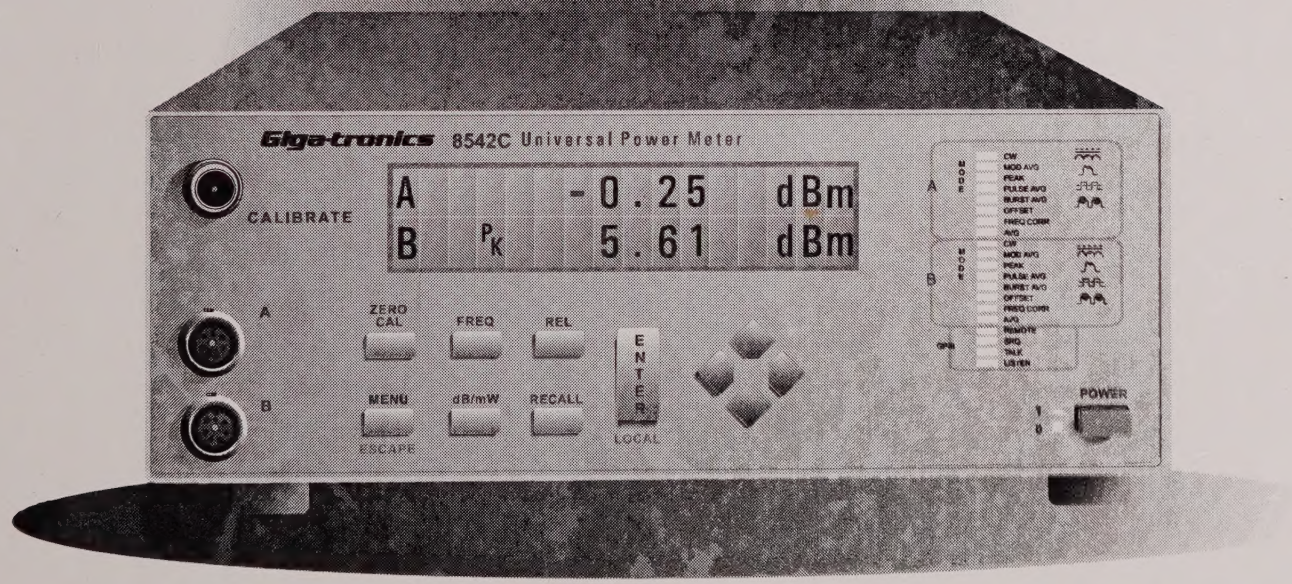
SERIES
8540C
UNIVERSAL
POWER
METERS

8540C



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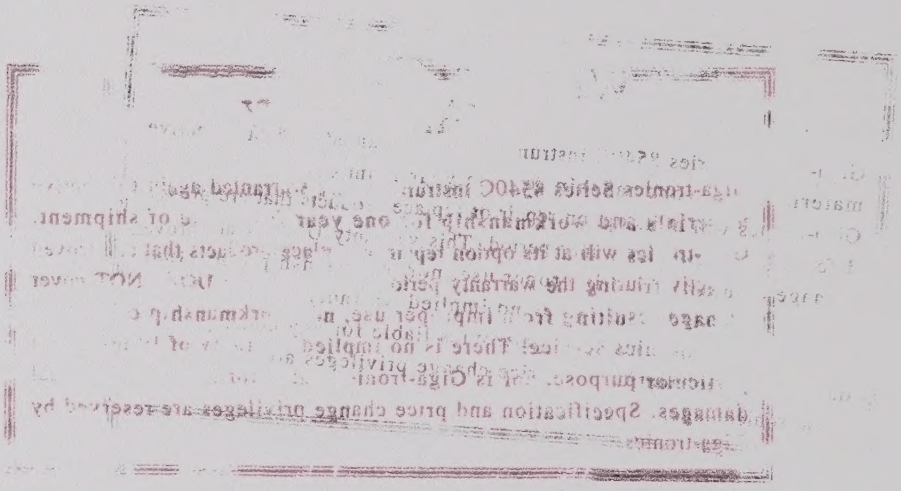

Model Numbers

Giga-tronics Service Contacts

Manual Part Number: 30280
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Print Date: January 1998

Giga-tronics

Operation & Maintenance Manual

Series 8540C
Universal Power Meters

The instrument has a 7-digit serial number, shown on a sticker on the rear panel.
This manual applies to all serial numbers which begin with 98, 99, or 00.

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Model Numbers

The Series 8540C includes two models: The single-channel Model 8541C and the dual-channel Model 8542C. Apart from the number of sensors they support, the two models are identical. Both models are referred to in this manual by the general term 8540C, except where it is necessary to make a distinction between the models.

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About This Manual

This manual contains the following chapters and appendices to describe the operation and maintenance of Series 8540C Universal Power Meters:

Preface: In addition to a comprehensive Table of Contents and general information about the manual, the Preface also contains a record of changes made to the manual since its publication, and a description of Special Configurations. If you have ordered a user-specific manual, please refer to page xvii for a description of the special configuration.

Chapter 1: Introduction: This chapter is an introduction to the instrument and it's performance parameters.

Chapter 2: Front Panel Operation: This chapter is a guide to the instrument's front panel keys, display and configuration menus.

Chapter 3: Remote Operation: This chapter is a guide to the instrument's GPIB remote control interface.

Chapter 4: Theory of Operation: This chapter provides a block diagram level description of the instrument and its circuits for maintenance and applications.

Chapter 5: Calibration and Testing: Procedures for inspection, calibration, and performance testing are outlined in this chapter.

Chapter 6: Maintenance: This chapter contains procedures for maintenance and troubleshooting.

Chapter 7: Parts Lists: This chapter lists all components and parts and their sources.

Chapter 8: Diagrams: This chapter contains schematics and parts placement diagrams for all circuits.

Appendix A: Sample Programs: Examples of programs for controlling the 8540C remotely over the GPIB.

Appendix B: Power Sensors: Selection data for power sensors, specifications, and calibration procedures.

Appendix C: Options: This appendix describes options available for the Series 8540C.

Changes that occur after publication of the manual, and special configuration data will be inserted as loose pages in the manual binder. Please insert and/or replace the indicated pages as detailed in the Technical Publication Change Instructions included with new and replacement pages.

Conventions

The following conventions are used in this product manual. Additional conventions not included here will be defined at the time of usage.

Warning

WARNING

The WARNING statement is enclosed in double lines and centered in the page. This calls attention to a situation, or an operating or maintenance procedure, or practice, which if not strictly corrected or observed, could result in injury or death of personnel. An example is the proximity of high voltage.

Caution

CAUTION

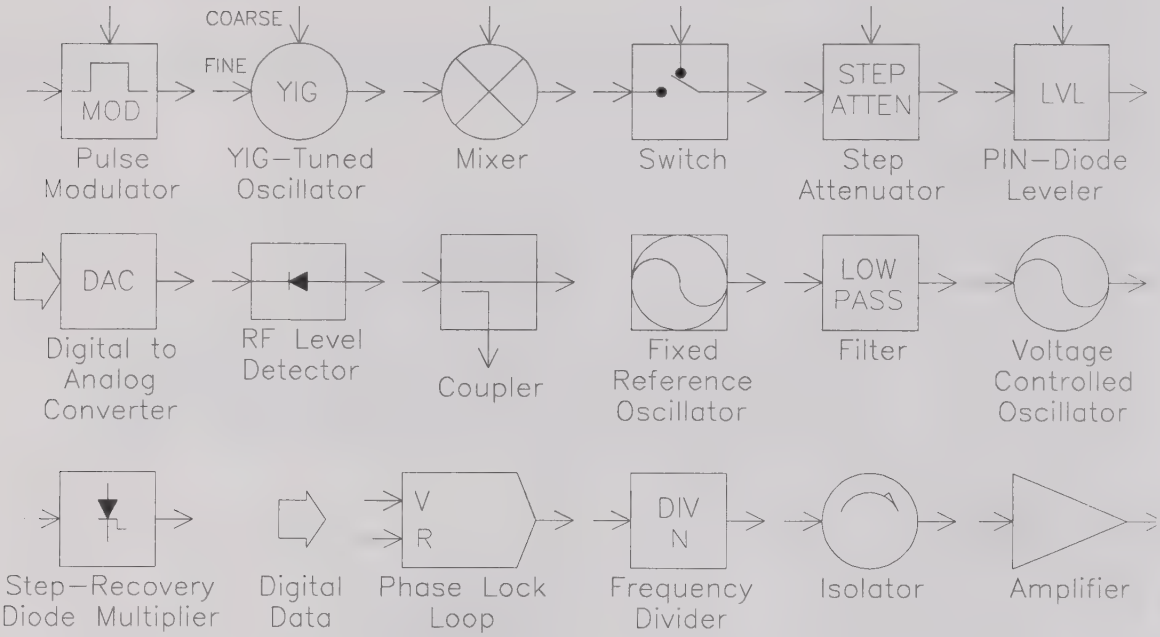
The CAUTION statement is enclosed within a single heavy line and centered in the page. This calls attention to a situation, or an operating or maintenance procedure, or practice, which if not strictly corrected or observed, could result in temporary or permanent damage to the equipment, or loss of effectiveness.

Notes

NOTE: A NOTE highlights or amplifies an essential operating or maintenance procedure, practice, condition or statement.

SYMBOLS

Block diagram symbols frequently used in the manual are illustrated below.



Record of Manual Changes

This table is provided for your convenience to maintain a permanent record of manual change data. Corrected replacement pages will be issued as Technical Publication Change Instructions, and will be inserted at the front of the binder. Remove the corresponding old pages, insert the new pages, and record the changes here.

Change Instruction Number	Change Instruction Date	Date Entered	Comments

Special Configurations

When the accompanying product has been configured for user-specific application(s), supplemental pages will be inserted at the front of the manual binder. Remove this page and replace it with the furnished Special Configuration supplemental page(s).

1 Introduction

1.1 Description

The Series 8540C are digital-controlled, self-calibrating power meters. They can measure the power of RF and microwave signals over a wide range of frequencies and levels, and in a variety of measurement modes, and can be operated manually from the front panel or remotely over the General Purpose Interface Bus (GPIB). See Section 1.3 for performance specifications.

The Series 8540C Universal Power Meters are available as the single-channel Model 8541C and the dual-channel Model 8542C, which can simultaneously measure and display signal data for two channels.

The Series 8540C and the 80600 line of power sensors provide enhanced performance in the measurement of complex modulation signals used in the communication industry. The 8540C maintains all functionality of Giga-tronics Series 8540B power meters as well as compatibility with all existing power sensor models.

1.1.1 Features

- CW, modulated, and peak power sensors
- >2000 readings/second in the Fast Buffered Mode (GPIB only)
- 90 dB dynamic range CW sensors
- +0.5% linearity
- True dual channel display
- HP 438A, 437B, and 436 simulation modes (GPIB only)
- EEPROM based CAL FACTOR correction sensors
- Modulated Average Power (MAP) mode
- Pulse Average Power (PAP) mode
- Burst Average Power (BAP) mode
- Wide modulation bandwidth – The 8540C is capable of accurately measuring signals with modulation frequencies up to 1.5 MHz with the 80601A sensor
- Dual-channel modulated measurements with the 8542C and 80400 or 80600 series power sensors
- Time-gating (Option 11) allows you to specify a time period referenced to a rear panel trigger during which power measurements are taken
- Password protection against unauthorized changes in data stored in EEPROMs.

1.1.2 Performance Characteristics

Performance specifications for models in the Series 8540C are presented in Section 1.3. Sensor specifications are contained in Appendix B. Options are detailed in Appendix C.

1.1.3 Weight and Dimensions

Series 8540C instruments weigh 10 lbs (nominal).
Dimensions are 3.5 inches high x 8.4 inches wide x 14.5 inches deep.

1.1.4 Power Requirements

100/120/220/240 Vac ±10%, 48-400 Hz, 20 W, typical. See Section 1.2 for details to set the voltage and install the correct fuse for the area in which the instrument will be used.

1.1.5 Environmental Requirements

Series 8540C instruments are type tested to MIL-T-28800E, Type III, Class 5, Style E for Navy shipboard, submarine, and shore applications except as follows:

- Operating temperature range is 0 °C to 50 °C (calibrator operating temperature range is 5 °C to 35 °C).
- Non-operating (storage) temperature range is -40 °C to +70 °C.
- Relative humidity is limited to 95% non-condensing.
- Altitude and EMI requirements are not specified.

1.1.6 Items Furnished

In addition to options and/or accessories specifically ordered, items furnished with the instrument are:

1 ea. - Power Cord
1 ea. - Detachable Sensor Cable (for Model 8541C), or
2 ea. - Detachable Sensor Cables (for Model 8542C)
1 ea. - Operation and Maintenance Manual

1.1.7 Items Required

The 8540C requires an external power sensor; see Appendix B for Power Sensor Specifications.

1.1.8 Tools and Test Equipment

No special tools are required to operate the Series 8540C. Test equipment required for calibration or performance verification is described in Chapter 4.

1.1.9 Cooling

No cooling is required if the instrument is operated within its specified operating temperature range (0 to 50 °C).

1.1.10 Cleaning

The instrument's front panel can be cleaned using a cloth dampened with a mild detergent; wipe off the detergent residue with a damp cloth and dry with a dry cloth. Solvents and abrasive cleaners should not be used.

1.1.11 Installation and Preparation for Use

The instrument is shipped in an operational condition and no special installation procedures are required.

1.1.12 Receiving Inspection

Use care in removing the instrument from the carton and check immediately for physical damage, such as bent or broken connectors on the front and rear panels, dents or scratches on the panels, broken extractor handles, etc. Check the shipping carton for evidence of physical damage and immediately report any damage to the shipping carrier.

Each Giga-tronics instrument must pass rigorous inspections and tests prior to shipment. Upon receipt, its performance should be verified to ensure that operation has not been impaired during shipment. The performance verification procedure is described in Chapter 5 of this manual.

1.1.13 Preparation for Reshipment

To protect the instrument during reshipment, use the best packaging materials available. If possible use the original shipping container. If this is not possible, a strong carton or a wooden box should be used Wrap the instrument in heavy paper or plastic before placing it in the shipping container. Completely fill the areas on all sides of the instrument with packaging material. Take extra precautions to protect the front and rear panels.

Seal the package with strong tape or metal bands. Mark the outside of the package "FRAGILE — DELICATE INSTRUMENT". If corresponding with the factory or local Giga-tronics sales office regarding reshipment, please reference the full model number and serial number. If the instrument is being reshipped for repair, enclose all available pertinent data regarding the problem that has been found.

☛ ***NOTE:*** If you are returning an instrument to Giga-tronics for service, first contact Giga-tronics Customer Service at ***(800) 444-2878*** or Fax at ***(510) 328-4702*** so that a return authorization number can be assigned. You can also contact Customer Service over their e-mail address ***repairs@gigatronics.com.***

1.2 Safety Precautions

This instrument has a 3-wire power cord with a 3-terminal polarized plug for connection to the power source and safety-ground. The ground (or safety ground) is connected directly to the chassis.

WARNING

If a 3-to-2 wire adapter is used, connect the ground lead from the adapter to earth ground. Failure to do this can cause the instrument to float above earth ground, posing a shock hazard.

The 8540C is designed for international use with source voltages of 100, 120, 220, or 240 Vac, ±10% at 50-400 Hz. The 8540C uses an internationally approved connector that includes voltage selection, fuse, and filter for RFI protection (see Figure 1-1).

CAUTION

The instrument can be damaged if connected to a source voltage with the line voltage selector set incorrectly. Before connecting the instrument to power, make sure that the line voltage selector is set for the correct source voltage.

1.2.1 Voltage Selection & Fuse Installation

When the instrument is shipped from the factory, it is set for a particular power line voltage (120 Vac for domestic destinations). The power line fuse for this setting is 0.75 A Slo-Blo. If the source voltage is to be 220 to 240 Vac, the fuse must be changed to 0.375 A Slo-Blo (see Figure 1-1).

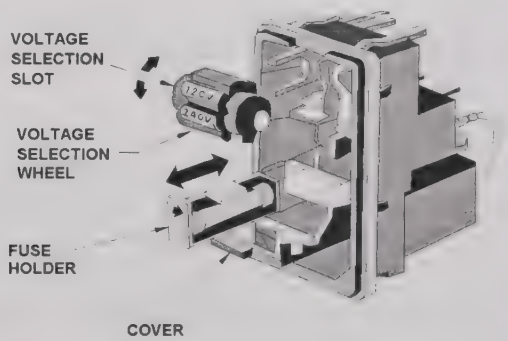


Figure 1-1. Voltage Selector and Fuse Holder

The voltage selector and fuse holder are both contained in a small covered housing directly above the ac power connecter. To gain access to them, open the cover using a small screwdriver or similar tool and proceed as follows:

1. To change the voltage setting:

   Use the same tool to remove the voltage selector (a small barrel-shaped component marked with voltage settings). Rotate the selector so that the desired voltage faces outward and place the selector back in its slot. Close the housing cover; the appropriate voltage should be visible through the window (see Figure 1-1).

2. To replace the fuse:

   Pull out the small drawer on the right side of the housing (it's marked with an arrow) and remove the old fuse. Replace with a new fuse, insert the drawer and close the housing cover (see Figure 1-1).

1.2.2 Power Sensor Precautions

Power sensor safety precautions, selection, specifications, and calibration are detailed in Appendix B to this manual.

1.3 8540C System Specifications

1.3.1 Power Meter

Frequency Range:	10 MHz to 40 GHz[1]
Power Range:	-70 dBm to +47 dBm (100 pW to 50 Watt)[1]
Single Sensor Dynamic Range:	
CW Power Sensors	90 dB[1]
Peak Power Sensors	40 dB, Peak, 50 dB, CW
Modulation Sensors	87 dB CW; 80 dB MAP/PAP; 60 dB BAP
Display Resolution:	User-selectable from 1 dB to 0.001 dB in Log mode and from 1 to 4 digits of display resolution in Linear mode.

1.3.2 Accuracy

Calibrator:	Power Sweep calibration signal to dynamically linearize the sensors.
Frequency	50 MHz nominal.
Settability	The 1 mW (0.0 dBm) level in the Power Sweep Calibrator is factory set to ±0.7% traceable to the National Institute of Standards and Technology. Measure with 15 seconds of setting calibrator to 0.0 dBm.
0.0dBm Accuracy	±1.2% worst case for one year over temperature range of 5 to 35 °C.
Connector	Type N connector, 50 Ω.
VSWR	<1.05 (Return Loss >33 dB).
System Linearity at 50 MHz for Standard Sensors[3]:	±0.02 dB over any 20 dB range from -70 to +16 dBm ±0.02 dB (±0.05 dB/dB) from +16 to +20 dBm ±0.04 dB from -70 to +16 dBm
Temperature Coefficient of Linearity:	<0.3%/ °C temperature change following Power Sweep Calibration. 24-hour warm-up required.
Zeroing Accuracy (CW) (Standard Sensors):	
Zero Set	<±50 pW[2] <±100 pW with 80400A and 80600A series modulation power sensors
Zero Drift	<±100 pW during 1 hour[2]
Noise	<±50 pW measured over any 1 minute interval. Three standard deviations.[2]

Notes:

1. Depending on sensor used (see Power Sensor details in Appendix B).
2. Specification applies at -50 dBm for 8030XA Standard Sensors. When measuring power levels Po other than -50 dBm, divide noise and zero specifications by $(10^{-Po/10})/(10^{-5})$. For other 80300 Series CW Sensors, specification applies at 20 dB above the minimum specified reading level. For Peak Power Sensors, see Appendix B and the 80350A Series Peak Power Sensor Data Sheet. Specified performance applies with Maximum averaging and 24 hour warm-up with temperature variation <3 °C.
3. Instrumentation, relative to 0 dBm.

1.3.3 Uncertainty Due to Instrument Linearity & Zero Set vs. Input Power

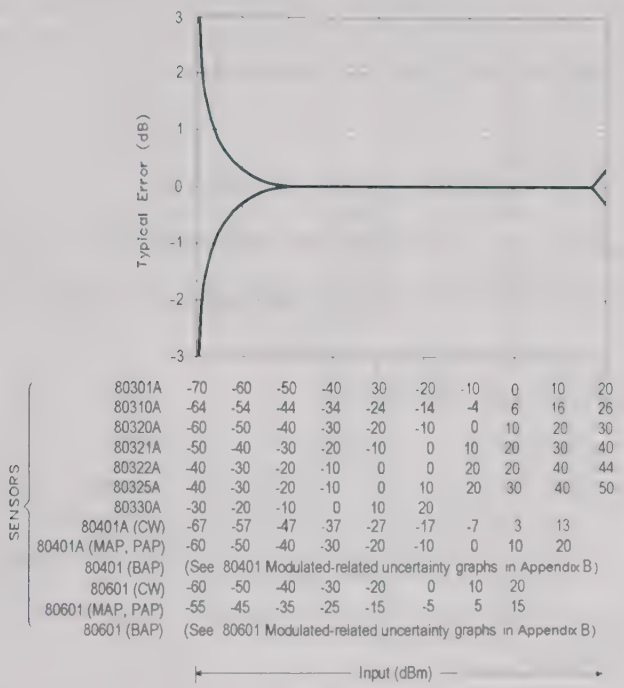


Figure 1-2. Uncertainty Due to Linearity & Zero Set

1.3.4 Measurement Rates

Measurement speed increases significantly using the 8540C data storage capabilities. Storing data in the power meter's memory for later downloading to your controller reduces GPIB protocol overhead. Up to 128,000 readings can be buffered. Table 1-1 illustrates typical maximum measurement rates for different measurement collection modes. The rate of measurement depends on several factors including the controller speed and the number of averages. The Fast Buffered Mode speed shown below does not include bus communication time.

Table 1-1. Collection Modes Measurement Rates

Measurement Collection Mode	Readings per Second (CW Measurement)	Readings per Second (MAP, PAP, BAP Measurement)
Normal (TR3) Continuous Single Readings	>30	15
Swift Mode, Continuous or Buffered, Bus/TTL triggered	>175	N/A
Swift Mode, Continuous or Buffered, Free-run triggered	>200	N/A
Fast Buffered Mode, Buffered Data, Time Interval = 0	2600	N/A
Fast Modulated Mode, Continuous Single Readings	N/A	30

Individual data points are read immediately after measurement in the Normal mode. The Normal mode and the Swift mode both slow down at low power levels (<-37 dBm for Standard Sensors) to average the effects of noise. The Swift mode allows triggering of individual data points and can store the data in the 8540C memory. The Fast Buffered mode also buffers measurement data. Measurement timing of individual data points is controlled by setting the time interval (1 to 5000 ms) between the data points following a trigger.

1.3.5 Remote Operation

GPIB Interface:	Allows all front panel operations and some GPIB-only operations to be remotely programmed in either IEEE-488 or IEC-625 formats.
Interrupts:	SRQs are generated for the following conditions: Power Up, Front Panel key actuation, Operation Complete, Illegal Command, and Instrument Self-Test error.

1.3.6 Fast Buffered Mode Controls

Trigger Source:	TTL or GPIB
Data Buffer Control:	Pre- or Post-measurement data is collected immediately either before or after receipt of the TTL or GPIB trigger.
Time Interval:	TIME ### - controls time interval in milliseconds between measurements. Accurate to 5%, typical.

1.3.7 Meter Functions

Averaging:	User-selectable auto-averaging or manual, 1 to 512 readings. Automatic noise compensation in auto averaging mode.
dB Rel and Offset:	Allows both relative readings and offset readings. Power display can be offset by -99.999 dB to +99.999 dB to account for external loss/gain.
Configuration Storage Registers:	Allows up to 20 front panel setups plus a last instrument state at power-down to be stored and recalled from non-volatile memory.
Power Measurements and Display Configuration:	Any two of the following channel configurations simultaneously: A, B, A/B, B/A, A-B, B-A, DLYA, DLYB (provided that neither sensor is being used for MAP, PAP, or BAP measurements).

1.3.8 Remote Inputs/Outputs

V PROP F Input (BNC):	Corrects power readings for sensor frequency response using sweeper voltage output. Input resistance = 50K. Does not operate in the fast measurement collection modes (normal mode only).
Analog Output (BNC):	Provides an output voltage of 0 to 10V from either Channel A or Channel B in either Log or Lin units. Does not operate in the swift and fast measurement buffered modes.
Blanking Output (BNC):	TTL high during power meter zero. Can be used to shut off RF output during sensor zero.
Trigger Input (BNC):	Accepts a TTL trigger input signal for swift and fast measurement buffered modes.
GPIB Connector:	Interfaces power meter to controller, IEEE-488 and IEC-625 remote programming

1.3.9 General Specifications

Temperature Range:	
Operating:	0 to 50 °C (32 to 122 °F)
Storage:	-40° to 70 °C (-40° to 158 °F)
Power Requirements:	100/120/220/240Vac ±10%, 48 to 440 Hz, 20VA typical
Physical Characteristics:	
Dimensions:	215 mm (8.4 in) wide, 89 mm (3.5 in) high, 368 mm (14.5 in) deep
Weight:	4.55 kg (10 lbs)

1.3.10 Accessories Included

1 ea 8540C Series Operating and Maintenance Manual

1 ea Power Cord

1 ea Detachable Sensor Cable (for Model 8541C)

or

2 ea Detachable Sensor Cables (for Model 8542C)

1.3.11 Options

Refer to Appendix C for a full description of options.

OPTION 01:	Rack Mount Kit
OPTION 02:	Add 256k buffer for Fast Buffered Power Readings. Stores 128,0000 readings.
OPTION 03:	8541C Rear Panel Connections (Sensor & Calibrator - deletes front panel connections)
OPTION 04:	8542C Rear Panel Connections (Sensor & Calibrator - deletes front panel connections)
OPTION 05:	Soft Carrying Case
OPTION 06:	Second Analog Output on 8542C. (-10 V to +10 V)
OPTION 07:	Side Mounted Carrying Handle
OPTION 08:	Transit Case (includes Soft Carrying Case)
OPTION 09:	Dual Rack Mount Kit (with assembly instructions)
OPTION 10:	Dual Rack Mount Kit (factory assembled)
OPTION 11:	Time Gating Measurement

1.3.12 Power Sensors

See Appendix B for power sensor selection, specifications, and calibration data.

2

Front Panel Operation

2.1 Introduction

This chapter describes the front panel operation of the Series 8540C Universal Power Meters. It includes descriptions of the front and rear panels, configuration, display menus, and practical applications. Section 2.2 describes the front panel; Section 2.3 describes the rear panel; Section 2.4 presents Configuration procedures; Section 2.5 describes the display submenus, and Section 2.6 offers guidelines for practical applications.

See Chapter 3 for information on remote operation with the General Purpose Interface Bus (GPIB).

2.2 The Front Panel

Although the 8540C has many modes of operation, the front panel design is very simple. The instrument is controlled and configured by means of displayed menus, which can be accessed and controlled with front panel pushbuttons.

The dual-channel Model 8542C front panel is illustrated in Figure 2-1. The single-channel Model 8541C is the same in appearance but does not include Channel B.

Figure 2-1. The 8542C Front Panel

2.2.1 Calibrator

The CALIBRATOR connector provides a reference power output for calibrating the amplitude response of a power sensor. The frequency of the output is fixed at 50 MHz. The level of the output is programmable. During a calibration run, the output level automatically sweeps from -30 dBm to +20 dBm in 1-dB steps.

2.2.2 Display Window

A two-line alphanumeric LCD screen displays measurements and configuration data.

2.2.3 LEDs

The LEDs to the right of the display window indicate operating modes and GPIB status. The column of LEDs can also be configured for use as a peaking meter display.

2.2.4 Power

The push-push power switch turns line power on and off.

2.2.5 Front Panel Keys

The front panel keys are located below the display window, and function as described below:

ZERO/CAL This key is for zeroing and calibration of a power sensor.

If zeroing and calibration are both required, the sensor must first be connected to the CALIBRATOR output connector. When the ZERO/CAL key is pressed, the sensor is zeroed, and then calibrated by an automatic program, which tests the sensor's response to different reference power levels and stores the resulting data in the 8540C memory.

For zeroing only, the sensor does need not to be connected to the CALIBRATOR output. If the ZERO/CAL key is pressed when the sensor is not connected to that output, the 8540C performs the zeroing function only.

When zeroing a sensor, it is best to connect the sensor to the device under test exactly as it will be used in measurement, and deactivate the RF output of that device. Zeroing the sensor in place is the best way to counteract system noise which could significantly effect low-level measurements. The RF Blanking output signal, which goes low during sensor zeroing, is provided by a BNC on the rear panel; this can be used as a control signal to turn off the RF source.

All active sensors should be zeroed whenever any sensor (whether it is calibrated or not) is added or removed.

FREQ This key specifies the frequency of an input signal, so that the 8540C can apply the appropriate frequency-specific cal factor to the measurement. These cal factors are retrieved from the sensor EEPROM.

If the frequency of the input signal changes so often that it is impractical to keep entering the frequency with the FREQ key, the frequency information can be conveyed to the 8540C by the use of a voltage input that is proportional to frequency (see the VpropF connector on the rear panel). When the 8540C is controlled remotely over the GPIB, the frequency information can be sent over the bus.

REL This key is for relative measurements (measurement values are not absolute but are expressed in dB relative to a reference level). The REL key establishes the currently measured power level as the reference for all subsequent measurements. Press [REL] a second time to disable relative measurement.

MENU/ESCAPE The MENU key accesses the configuration menus. It also functions as the ESCAPE key because it exits a configuration menu, abandoning any configuration choices that were made within the menu up to that point.

dBm/mW This key toggles between logarithmic measurement units (dBm, which is the default condition) and linear units (mW). The display can be configured to use both units simultaneously, but this must be done through the Meas Setup configuration menu).

RECALL The recall button retrieves a stored configuration of the 8540C (configurations are saved in registers 1 through 20, using the Save Setup configuration menu). Use the left/right cursor keys to choose between Preset and Reg#, and the up/down cursor keys to select a register number. Choosing the Preset configuration restores the 8540C default conditions (it does not undo the calibration of the sensors, however). Choosing register 0 restores the conditions which existed prior to the last configuration change.

ENTER/LOCAL The ENTER key makes menu selections and enters selected option or values. It is also called the LOCAL key because it switches from remote control to local control.

Cursor Keys These four keys are arranged in a diamond pattern and move the display vertically through available submenus, and move the display cursor (underline) horizontally within specific menus.

2.2.6 Sensor Inputs

The **A** and **B** sensor input connectors (located directly below the CALIBRATOR connector) connect the cables from the power sensors to the power meter. In instruments with Option 03, the sensor inputs are relocated to the rear panel.

Caution

When connecting sensor cables to these inputs, the cable pins must be aligned properly. Orient the cable so that the guide on the end of it aligns with the notch on the sensor input. If the connector does not seem to fit, forcing it will only damage the connector pins.

2.3 The Rear Panel

The rear panels for the 8541C and 8542C are identical and are illustrated in Figure 2-2.

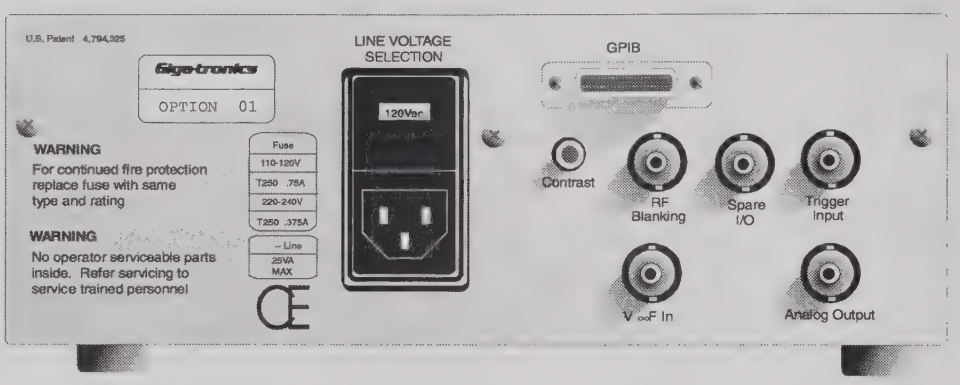


Figure 2-2. The 8540C Rear Panel

2.3.1 Inputs & Outputs

BNCs

Five BNC-type connectors to provide input and output signals for interfacing the 8540C to other equipment.

- **RF Blanking** provides a TTL output that goes high during zeroing of a sensor to send a temporary RF Off trigger to a signal source.
- **Trigger Input** accepts a TTL input for triggering of high speed measurements under GPIB control.
- **V α F In** accepts a voltage input that is proportional to frequency and causes the 8540C to apply appropriate frequency-related cal factors.
- **Analog Output** provides an output voltage that is proportional to the measured power level.
- **Spare I/O** is for a second Analog Output when Option 06 is installed.

Others

- **GPIB** (a 24-pin connector to connect the 8540C to other equipment over the GPIB).
- **Line Voltage Selection** houses the ac power connector and includes the fuse and line voltage selector.

2.4 Configuring the 8540C

The 8540C front panel LCD window normally displays measurement data, but it also displays configuration menus. To select the menu mode, press [MENU]. While in menu mode, the display can be returned to the measurement mode by pressing [MENU] again (in this context, the MENU button is the ESCAPE button).

The 8540C can be password-protected to prevent unauthorized changes in Calibrator and Cal Factor data stored in EEPROMs in the 8540C or its sensors. It is activated with the front panel menus (see Section 2.4.3 for a description of the menus and their usage). The 8540C is shipped from the factory with no password specified.

2.4.1 How the Menus Work

There is a hierarchy of menus; each line on the main menu represents a submenu, and some of the items on those submenus are further submenus.

Menus are displayed one line at a time, with the word *more* accompanied by up or down arrows to indicate whether there are additional lines above or below the line currently displayed. The Up/Down cursor buttons also browse through the lines of a menu. To select the currently displayed line, press [ENTER].

When an entry window is reached (that is, when the line that has been selected represents a configuration choice to be made, not a submenu), the cursor buttons (usually the Left/Right buttons) are step through the list of choices. If a numeric value is to be entered, a base value is displayed, and the cursor buttons increment or decrement this value (the Left/Right cursor buttons select a digit, and the Up/Down cursor buttons then step the value of that digit up or down).

After the desired value is set, or the desired choice selected, press [ENTER].

☛ ***NOTE:*** If you leave the menu mode without pressing [ENTER], the selections you made will not take effect.

Entering a selection usually returns the display window to the measurement mode. However, if the selection you made requires further configuration choices, another menu may be displayed.

The menus are dynamic rather than fixed; the display adapts itself to the current operating mode and the type of sensor or sensors connected. For example, the DLY measurement options are applicable only to peak power measurement; therefore, the menu displays these options only if a peak sensor is attached and is set up to measure peak power.

2.4.2 Menu Structure

Table 2-1 illustrates the menu structure. For specific information about the individual menu items, see Section 2.5. The format of these menus, as they are actually displayed, is context-dependent; some menu options shown here may not be displayed if they are not applicable to the sensors that are currently connected, or if they are not applicable to the measurement mode that is currently selected. For example, menu options related to the PAP mode will not be displayed if a CW sensor is attached, because a CW sensor cannot be used in the PAP mode.

Table 2-1. Configuration Menu Structure

Main Menu Item	Subsequent Menus / Entry Windows		
A, B, A/B, ..., OFF	Top Line Bot Line	Choose from: OFF, A, B, A/B, B/A, A-B, B-A, DLY_A, DLY_B *[The format of this entry window is particularly subject to context-dependent variations; see Section 2.5.1]*	
Meas Setup	Average	Avg A Avg B	Choose from: Auto, 1, 2, 4, 8, 16, 32, 64, 128, 256, 512
	Offset	A (dB) B (dB)	[increment or decrement the displayed value]
	Resolution	Top Line = x.xx Bot Line = x.xx	[adjust left or right as needed]
	Peak Hold	Choose from: OFF, ON	
	Crest Factor	Choose from: OFF, ON	
	Min/Max	Choose from: OFF, ON (and Bottom Line/Top Line if applicable)	
	Limits	Top Line Bot Line	Choose from: OFF, ON [if ON is chosen, the limits must be defined; increment or decrement]
	dBm/mW Setup	Top Line Bot Line	Choose from: Lin, Log
	Rel Setup	Top Line Bot Line	Choose from: ON, OFF
	Advanced	Burst Start Exclude	Num. of Samples: A Num. of Samples: B [increment or decrement]
		Burst End Exclude	
		Burst Dropout	Time: A / Time: B Choose from: .017, .026, .035, etc (values in ms).
Sensor Setup: CW sensor	(No configuration is required if a CW sensor is connected.)		
Sensor Setup: Peak Sensor **[select A or B]**	CW	(No further configuration is required if CW is selected.)	
	Int	Set Trig Level (dBm)	[increment or decrement the displayed value]
		Set Samp Delay (ns)	
		DLY Offset (ns)	
	Ext	Set Trig Level (V)	
		Set Samp Delay (ns)	
		DLY Offset (ns)	

Main Menu Item	Subsequent Menus / Entry Windows		
Sensor Setup: Modulation Sensor [80400 Series] [select A or B]	CW	(No further configuration is required if CW is selected.)	
	Modulated Avg	(No further configuration is required if Modulated Avg is selected.)	
	Pulse Avg	Duty Cycle [increment or decrement the displayed value]	
	Burst Avg	(No further configuration is required if Burst Avg is selected.)	
Ref Power On/Off	Choose from: On or Off		
Config	Peaking Meter	Choose from: Status, PkA, PkB	
	GPIB	Mode	Choose from: 8541, 8542, 436A, 437B, 438A
		Address	Choose from: 0-30 (listen & talk), 40 (listen only) and 50 (talk only).
	Analog Out	Std Output [if Option 06 is installed, there are two outputs; if so, select OFF in order to get to the menu for that option]	Choose from: Off, Bot Line, Top Line
		Mode	Choose from: Log, Lin
	V prop F [select A or B]	Choose from: OFF, ON If ON is selected, two values must be defined	Freq. at 0 Volts (GHz) Scale Factor (V/GHz) [increment or decrement the displayed values]
	Sound	Choose from: ON, OFF	
Service	Sensor ROM [select A or B]	Choose from a wide variety of parameters that can be set.	
	Calibrator	Power	Choose from: OFF, or a value in dBm [increment or decrement the displayed value].
		EEPROM [data to be entered: Serial#, Cal Factor, Date, Time, WRITE]	WRITE: CALIB Clear, or PASSWORD Set
	Test Functions	Choose from a wide variety of diagnostic tests.	
	Software Version	Displays information about the currently installed software.	
	Clear All Memory	Clear RAMs of configuration data.	
Save Setup	Save to Reg# [specify a number from 1 to 20]		

2.4.3 Password Protection

The password feature prevents unauthorized changes in Calibrator and Cal Factor data stored in EEPROMs in the 8540C or its sensors. It is activated with the front panel menus (see Table 2-1 for a description of the menus and their usage). The 8540C is shipped from the factory with no password specified.

To get to PASSWORD Set, select the Service menu, then the Calibrator submenu (or the Sensor ROM submenu to provide password protection of sensor memory). Then select EEPROM, then WRITE. At WRITE, the choice is between CALIB Clear and PASSWORD Set; select the latter. The password is a numeric code. To enter it, use the cursor keys to increment or decrement the digits displayed in the screen and press [ENTER]. Press [ENTER] again to confirm the password. The password is now stored in the 8540C memory, and EEPROM data cannot be changed without entering the password.

The password can be changed or cleared by repeating the above steps and entering the existing password, then set a new password by selecting SET. Clear the password by selecting CLEAR, or just rewrite the data by selecting ON.

If a password was set previously and is not known, you can disable password protection by moving the A2W1 jumper on the Analog PC board (A2) from the factory-set position A to position B.

2.5 The Submenus

2.5.1 A, B, A/B, ..., Off

This submenu determines what will be shown on the top and bottom lines of the display window. The existing measurement setup determines which choices are shown in the menu; options which do not apply to the power meter and its sensors, as they are currently configured, will not be shown.

The top and bottom lines of the display are configured independently; use the up/down cursor keys to choose the top or bottom line, then use the right/left cursor keys to choose one of the available display formats. Any of the options shown below can be selected for either the top line or the bottom line.

A the display line for Sensor A

B the display line for Sensor B (Model 8542C only)

A/B the reading of Sensor A divided by the reading of Sensor B (Model 8542C only)

B/A the reading of Sensor B divided by the reading of Sensor A (Model 8542C only)

A-B the reading of Sensor A less the reading of Sensor B (Model 8542C only)

B-A the reading of Sensor B less the reading of Sensor A (Model 8542C only)

Display Line Formats for the CW Mode

TOP or BOTTOM:	A	B	A/B	B/A	A-B	B-A	OFF

The top and bottom line settings are chosen as a unit for the PEAK mode. One line of the display shows the measurement, and the other line shows the delay value. The choices in this mode are:

Display Window Formats for the PEAK Mode

TOP:	A	B	DLY_A	DLY_B
BOTTOM:	DLY_A	DLY_B	A	B

2.5.2 Meas Setup

This submenu is defines conditions of measurement for each sensor. The items on the submenu are: Avg, Offset, Resolution, Min/Max, Limits, dBm/mW, and Relative. Use the up/down cursor keys to view these items, and the ENTER key to select one of them.

Average Measurements can be averaged over a period of time which is referred to as the filter time. Increasing the filter time increases the stability of the display, at the cost of increased time required for a measurement. The filter time is equal to 40 ms times the averaging factor (for an averaging factor of 1, the filter time is equal to 40 ms or the reading update time, whichever is greater). To increase measurement speed, choose a lower averaging factor. The choices are: AUTO, 1, 2, 4, 8, 16, 32, 64, 128, 256, and 512. Use the up/down cursor keys to view these choices, and the Enter key to select one of them. If AUTO is selected, the filter time is automatically adjusted for the ambient noise level.

Offset A specific offset in dB (positive or negative) can be added to the measured power. A beginning value of 0.000 dB is displayed. Use the left/right cursor keys to select a digit, and the up/down cursor keys to increment or decrement the selected digit. Use the ENTER key to select the adjusted offset value.

Resolution The display resolution can be set independently for the top line and bottom line of the display. Use the up/down cursor buttons to select the top line or the bottom line. Use the right/left cursor buttons to modify the resolution as symbolized by x's (the range of choices is *x* through *x.xxx*). Use the ENTER key to select the adjusted resolution.

Peak Hold In modulated measurement modes (MAP, PAP, or BAP), this feature is holds the maximum value measured since it was enabled. The displayed value changes only when it is rising to a new maximum (or when it is reset by pressing [ENTER], in which case the displayed value drops to the present measured value and the process resumes).

Crest Factor This feature is very similar to the Peak Hold feature described above, except that what is displayed is the ratio of the held maximum value to the average value, expressed in dB.

Min/Max The Min/Max feature provides a continuously updated display of the highest and lowest values measured so far; both are displayed on one line, while the other line displays the current measurement of the channel being monitored. Use the Up/Down cursor buttons to select OFF, Bottom Line, or Top Line, and press [ENTER]. The line that is selected represents the channel to be monitored; the other line displays the minimum and maximum measured values. To reset these values to the current measurement, return to the Min/Max entry window and press [ENTER] twice.

Limits High and low limits can be defined for each channel; if the sound function is activated, an audible tone is generated when a limit is violated. Arrows pointing up or down are displayed during a limit violation, to indicate whether the upper limit or the lower limit was violated.

dBm/mW The top and bottom lines of the display can be configured for logarithmic (dBm) or linear (mW) display modes. Ratio measurements (A/B or B/A), are expressed in dBr (logarithmic) or %r (linear).

Rel Setup Normally, when [REL] is pressed, each line of the display shows a relative measurement (when the key is pressed, the present measured value is recorded, and all subsequent measurements are expressed in dB or % relative to that recorded value). The Rel Setup entry menu provides a means of selectively enabling or disabling the relative measurement mode for the top line, the bottom line, or both. Use the Up/Down cursor keys to select the top line or the bottom line; then use the Right/Left cursor keys to select ON or OFF, and press [ENTER].

Advanced This menu includes three special features which may be of use in certain applications of the Burst Average Power measurement mode.

Burst Start Exclude: This feature is masks a portion of the beginning of a burst to exclude overshoot and other distortions from the measurement. The number of samples to be excluded must be defined; use the Up/Down cursor keys to select the desired number of samples, and press [ENTER] (selecting zero samples effectively disables this feature).

Burst End Exclude: This feature is masks off a portion of the end of a burst to exclude overshoot and other distortions from the measurement. The number of samples to be excluded must be defined; use the Up/Down cursor keys to select the desired number of samples, and press [ENTER] (selecting zero samples effectively disables this feature).

Burst Dropout: This feature is modifies the definition of a burst, so that a brief dropout is not interpreted as the end of a burst. A dropout time must be defined; use the Up/Down cursor keys to select one of a series of values displayed in ms (.17, .26, .35, etc.), and press [ENTER].

2.5.3 Sensor Setup

This menu is dynamic; its contents are determined by the type of sensor which has been connected to the selected sensor input port (the 8540C is able to identify the sensor by reading its EEPROM data).

CW sensor setup If a CW sensor is connected, no sensor configuration is needed.

Peak Sensor Setup The Series 80350A peak sensor can be used in three modes: CW, Internally Triggered, and Externally Triggered. Use the Left/Right cursor buttons to select the desired mode, and press [ENTER].

CW No further configuration is required if the CW mode is selected.

Int In the Internally Triggered mode, peak power will be sampled at a point which is defined by a trigger level, a delay, and a delay offset. The delay offset feature is a convenience in some applications (for example, when measuring pulse width from a point other than the trigger level, or when comparing the levels of various pulses within a pulse train). When Set Trig Level is displayed, use the cursor buttons to adjust the displayed value (in dBm), and press ENTER. When Set Samp Delay is displayed, use the cursor buttons to adjust the displayed value (in ns, µs, or ms), and press [ENTER]. When Dly Offset is displayed, use the cursor buttons to adjust the displayed value (in ns, µs, or ms), and press [ENTER].

Ext The Externally Triggered mode is very similar to the Internally Triggered mode described above, except that the basis of triggering is a voltage input from an external source. Configuration of this mode is the same as for the internal mode, except that the trigger level is specified in volts rather than dBm.

Modulation Sensor Setup

CW No further configuration is required if the CW mode is selected.

Modulated Avg No further configuration is required if the Modulated Average mode is selected.

Pulse Avg The Pulse Average is similar to the Modulated Average mode, except that the user is able to specify a duty cycle (for pulse modulated inputs). When Set Duty Cycle is displayed, use the cursor button to adjust the displayed value (in %), and press [ENTER]. The range is 0.001% to 99.999%.

Burst Avg No further configuration is required if the Burst Average mode is selected.

2.5.4 RF Power On/Off

This entry window submenu activates and deactivates the front panel CALIBRATOR output (to adjust the value of the output, see the Service submenu). Use the left/right cursor buttons to select ON or OFF, and press [ENTER].

2.5.5 Config

Peaking Meter The 20 status LEDs on the front panel can be configured to serve as a peaking meter (that is, the stack of the LEDs turn on from the bottom up to give a rough visual indication of changes in the currently measured power level). The options are Status, PkA, and PkB. If PkA is selected, the LEDs serve as a peaking meter for Channel A. If PkB is selected, they serve as a peaking meter for Channel B. If Status is selected, the LEDs revert to their original role as status indicators.

GPIB This option gives the user an opportunity to specify the IEEE-488 GPIB address and the emulation mode for the 8540C. The choices of address are 0 through 30 (listen & talk), 40 (listen only), and 50 (talk only). The choices of emulation mode are 8541, 8542, 436A, 437B, and 438A.

Analog Out The analog output is an output voltage, proportional to measured power, that can be applied to auxiliary test equipment (such as a data recorder). The choices of output source are Top Line, Bottom Line, and Off. The choices of mode are Log and Linear. The output source choices are displayed under the heading Std Output. If Option 06 is installed, there are two outputs to be configured; in that case, select OFF under Std Output in order to reach the Option 06 configuration menu.

VprofF The VpropF (voltage proportional to frequency) connector accepts a voltage input in the range of 0 to +10V, which the 8540C uses to determine the frequency of the RF input, so that appropriate correction factors (stored in the probe's EEPROM) can be applied. The voltage input is supplied by a V/GHz output from the signal source. Select ON to activate this function. Two values must be defined for VpropF: the frequency at 0 Volts (specified in GHz) and the scale factor (specified in V/GHz). The V/GHz output connector on the frequency source is usually labeled with the scale factor.

Sound A speaker within the chassis produces audible clicks and tones, in order to register keystrokes, and to draw attention to certain conditions (for example, if a limit has been exceeded, or a calibration process has been completed). To activate or deactivate this speaker, select ON or OFF.

2.5.6 Service

Sensor ROM — This menu is records data in a power sensor's EEPROM. Select the sensor (A or B), and a series of entry windows appears. Normally, this menu is used only at the factory for instrument configuration. It should not be used in the field except under direction by the Giga-tronics customer service department. Carefully record all existing settings before changing them, so that they can be restored if necessary.

Calibrator — The CALIBRATOR output produces a reference signal to calibrate power sensors. The reference signal is at 50 MHz (CW); its level is programmable in 1 dB increments over a range of -30 to +20 dBm. The level at 0 dBm is factory set to ±0.7%, traceable to the National Institute of Standards Technology (within 15 seconds of setting a 0.0 dBm level). Output levels are subject to drift over time, and are considered accurate during a calibration run or within a few minutes of setting a fixed reference level.

Test Functions — This menu makes available a number of diagnostic tests which are normally used only by factory personnel. If you consult the Giga-tronics customer service department, you may be given instructions on how to use one or more of these tests.

Software Version — Selecting this menu item causes the window to display the version of software that is installed in the instrument.

Clear All Memory — Selecting this item causes all configuration data currently stored in the 8540C RAM to be cleared. Data stored in sensor EEPROMs is not affected.

2.5.7 Save Setup

Up to twenty different configurations can be stored in non-volatile memory. When Save Setup is selected, the entry window shows Save to Reg# 1. The Up/Down cursor buttons increment or decrement the number under which the current configuration will be saved. The range of numbers is 1 to 20. A setup that has been saved in memory can be retrieved by means of the RECALL button on the front panel.

2.6 Measurement Guide

This section of the manual presents simple guidelines for practical application of the 8540C. See Section 2.6.10 for mode restrictions.

2.6.1 Using the Power Sweep Calibrator

The Power Sweep Calibrator automatically calibrates the power sensor to the power meter. The power sweep operates from -30 to +20 dBm (the complete, non-square-law operating region) and transfers the inherent linearity of an internal, thermal-based detector to the balanced diode sensors. Output is NIST-traceable at 50 MHz, 0 dBm to an accuracy of ±0.7% (±1.2% over one year).
(Note: NIST is the *National Institute of Standards and Technology.*)

2.6.2 806XX Sensor Operation

The Series 806XX power sensors are designed for the precise measurement of signals with wide modulation bandwidths (up to 1.5 MHz). In terms of the various measurement modes (i.e., MAP, BAP, etc), the 806XX sensors are operated exactly as the Series 804XX sensors described in Section B.1.

There is one distinction regarding the operation of the 806XX sensors. Below 200 MHz, the modulation bandwidth of the sensor is limited by a filter which is electronically switched in the sensor. This is done to keep the RF signal out of the base band signal processing circuitry. When a 806XX sensor is calibrated on the meter for the first time (the meter reads UNCALIBRATED before calibration), the unit is set to the default setting of MAP mode with frequency correction set to 1 GHz. This allows the sensor to measure signals with wide-bandwidth modulation. For frequencies of 200 MHz or below, the frequency correction must be set to the measurement frequency to avoid measurement error.

The Series 806XX sensors are compatible with the 8541C and 8542C and later configurations.

2.6.3 Sensor Calibration

The procedure for calibrating a sensor is:

1. Connect the power sensor to the 8540C power meter with the power sensor cable.
2. Connect the power sensor to the 8540C CALIBRATOR output.
3. Press ZERO/CAL.

The 8540C will automatically verify that a sensor is attached to the CALIBRATOR connector. It will then zero and calibrate the sensor.

Refer also to the Power Sensor Calibration Procedures in Appendix B of this manual.

2.6.4 Zeroing at Low Power Levels

The sensor should be zeroed just before recording final readings in the lower 15 dB of the power sensor's 90 dB dynamic range (that is, for readings below -55 dBm, in the case of standard sensors).

1. Turn off the source output before you zero the sensor. The microwave source must output less than -74 dBm of total noise power during RF Blanking for proper zeroing. The source signal power should be less than -90 dBm.
2. Press the ZERO/CAL key to start the zeroing process. If more than one sensor is connected to the power meter, a channel selection menu will appear.

The sensor should remain connected to the signal source during zeroing. By turning off the source instead of disconnecting the detector, the zeroing process automatically accounts for ground line voltages and connector interface EMF.

Caution

Sensor diodes can be destroyed by momentary or continuous exposure to excess input power. The maximum power (peak or average) that can be applied to the detector elements without resulting damage is printed on the side of the sensor housing. For standard CW sensors, and peak power sensors, this maximum level is +23 dBm (200 mW). Standard sensors should not be used above +20 dBm (100 mW), because this may degrade the sensor's performance even if it does not burn out the diodes.

When measuring pulsed signals, it is important to remember that the peak power may be much greater than the average power (it depends upon the duty cycle). It is possible to overload the sensor with a pulsed signal, even though the *average* power of the signal is far below the maximum level.

To measure higher power levels, use a high power sensor, or else reduce the signal amplitude using a directional coupler or a precision attenuator.

2.6.5 Measuring Source Output Power

The procedure is:

1. Connect the power sensor to the RF output of the microwave source.
2. Verify that the microwave source's RF output is ON.
3. Press [FREQ]; enter the operating frequency (using the cursor keys to adjust the value), and press [ENTER].
4. The 8540C is now displaying the microwave source's output power. Adjust the source's amplitude to the desired level.

The 8540C responds rapidly to amplitude changes. Ranging is automatically performed in real time through a 90 dB dynamic range, using CW or modulated sensors. The peak sensor dynamic range is 40 dB, Peak, and 50 dB, CW.

Entering the operating frequency enables the 8540C to automatically apply frequency calibration factors appropriate to the sensor being used. The operating frequency can be communicated to the 8540C using the front panel menus, the GPIB, or the VpropF voltage input. (The input connector for the VpropF function is labeled VαF IN on the 8540C rear panel.)

2.6.6 Using the Peaking Meter

The LEDs on the right side of the 8540C front panel can be configured as a 20-segment bar graph.

1. Press [MENU]. Select the Config menu. Select Peaking Meter.
2. Use the cursor to select PkA or PkB, and press [ENTER].
3. Adjust the source's amplitude control and observe the peaking meter.

The LED bar graph provides a linear display of power level on a decade range basis. For example, a power level of 3 dBm produces an approximate 50% response on the peaking meter.

2.6.7 High Power Level Measurements

High power amplifiers and transmitters can damage standard sensors. High power sensors make it possible to measure these devices without using attenuators and measurement offsets.

For example, if the output of an RF source is amplified to +30 dBm (1 Watt), this signal cannot be measured directly using a standard sensor, because the sensor's maximum input level is +23 dBm (and any level above +20 dBm is potentially harmful to a standard sensor). The signal would have to be attenuated, and the attenuation would have to be corrected for, by means of a measurement offset. However, if a 5 Watt high power sensor is used, any power level up to +37 dBm can be measured directly, without the use of an attenuator.

2.6.8 Modulated Measurement Modes

The 8540C series of power meters expands upon the capabilities of the previous 8540 power meters in a number of ways. In the past, power measurements of modulated signals (pulse, multi-tone, AM, etc.) required that the signals be attenuated to levels less than -20 dBm, to avoid errors due to sensor nonlinearity. The 8540C, when used with a 80401A series sensor, eliminates this restriction, and brings the speed and accuracy of diode sensors to the power measurement of modulated signals. Basic measurement procedures are presented below, along with some useful tips on how to get the most out of the new modulated measurement modes.

The new modulated measurement modes are available through the sensor setup menu when the active sensor is an 80401A. The 8540C features three modulated measurement modes:

- Modulated Average Power (MAP)
- Pulse Average Power (PAP)
- Burst Average Power (BAP)

MAP and PAP modes measure the true average power of modulated and pulsed signals. PAP mode differs from MAP mode only in that it allows you to specify a duty cycle figure, which is automatically factored into the measurement. In BAP mode, the true average power within the pulse is measured (the pulse pattern is detected automatically, so there is no need for you to specify the duty cycle).

MAP Mode

The Modulated Average Power (MAP) mode measures RF signals which are amplitude modulated, pulse modulated, or both. In the MAP mode the 8540C calculates the average RF power received by the sensor over a period of time controlled by the time constant of the internal digital filter. The result is comparable to measurement by a thermal power sensor.

In this mode, the 8540C measures the average power of CW and modulated signals, such as:

- AM
- Two-tone
- Multi-carrier
- Pulse modulation
- Digital modulation (QPSK, QAM, etc...)

For example, if an RF signal pulse modulated at 50 Hz with a 10% duty cycle is measured with the averaging factor set to 128, the filter settling time will be 5.12 seconds (40 ms times 128) and each reading will include 256 pulses (50 Hz times 5.12 seconds); the measured power reading will be 10% of the peak power during pulse ON periods. Because the signal is modulated at a low pulse rate (below about 1 kHz), the 8540C will synchronize the readings precisely with the start of a pulse so that each displayed reading is averaged over a whole number of pulses (that is, there are no fractional pulses included in the measurement). This eliminates a significant amount of noise from the readings. It is important to remember that even though the filter settling time has been set to a long time constant of 5.12 seconds, the update rate of the meter will be much faster, and even the first reading will be very close to the fully settled value.

PAP Mode

The Pulse Average Power (PAP) mode is similar to the MAP mode, but it measures pulse modulated signals having a known duty cycle. You can specify this duty cycle and the 8540C will automatically correct the measurements so that the displayed readings indicate the peak RF power during pulse ON periods.

For example, when measuring a pulse modulated signal with 50% duty cycle, MAP mode would give a reading 3 dB lower than the reading that would be given by PAP mode with the duty cycle factor set to 50%.

☛ ***NOTE:*** The duty cycle correction presumes a perfectly rectangular profile for the RF pulse shape. Any abnormality such as overshoot, undershoot, slow rise time or fall time, inaccuracy of the duty cycle, or deviation from a flat pulse response will cause errors in the indicated reading.

BAP Mode

The Burst Average Power (BAP) mode measures the average power during an RF burst. This mode is very useful for measurement of pulse modulated signals which are not flat or have amplitude modulation during the pulse ON period, as in the case of TDMA (Time Division Multiple Access) communications signals. In this mode, the 8540C recognizes the beginning and end of a burst of RF power and takes an average of the power during that burst. The RF level can vary over a wide range during the burst as long as it remains above a noise threshold, which is automatically calculated by the 8540C. As soon as the RF power drops below the noise threshold, the RF burst is complete and all further readings are discarded until the next burst starts.

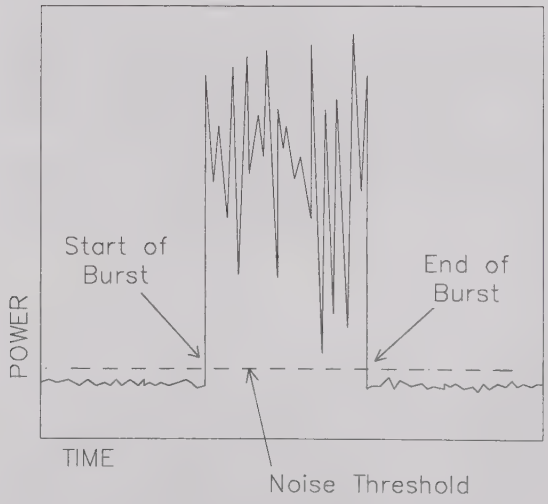


Figure 2-3. Burst Measurement

In BAP mode, the 8540C automatically determines which portions of the signal are in the pulse and which are not. In computing the average power, the 8540C uses only those portions that are within the pulse. The result is that, independent of the signal's pulse duty cycle, the meter always reads the average power in the pulse or burst. As with the PAP mode, when measuring a pulse modulated signal with 50% duty cycle, the reading in the BAP mode would be 3 dB higher than in the MAP mode. However, in the BAP mode, the signal's duty cycle can change dynamically in time without affecting the meter reading. In the PAP mode, the duty cycle factor must be entered to match the duty cycle of the pulsed signal.

2.6.9 Measurement Collection Modes

Using a wide range of CW and Peak Power Sensors and the GPIB fast measurement collection modes, the Series 8540C meters provide typical reading speeds of >200 readings per second in the free-run Swift mode, 30 readings per second in the Fast Modulated mode, and >2000 readings per second in the Fast Buffered mode. Three Swift mode triggering controls are available: Fast free-run, bus triggered, and TTL triggered modes. Bus and TTL allow triggering control of individual measurement points. Data can be stored in an internal data buffer or read immediately.

Fast buffered power readings are internally buffered for readout at the completion of the fast buffered interval. Maximum measurement rate is about 2600 readings per second. Data conversion and GPIB communication time are not included in this figure. The maximum buffer size is 5000 readings (or about 2.1 seconds at the maximum reading rate). The Option 02 buffer increases this to 128,000 readings.

CW Mode

This mode is for measuring an unmodulated Continuous Wave (CW) signal. In this mode the RF signal level must be constant for accurate readings to be made. If the signal level changes, a settling time for the internal digital filter is required in order for measurements to be made to the specified accuracy.

The settling time (the time required for a measurement based on an averaging of samples to adapt to a changed condition and become accurate again) is affected by various factors. The maximum settling time is equal to 40 ms multiplied by the averaging factor (for example, if the averaging factor is 128, the maximum settling time is 5.12 seconds). In most situations the actual settling time is well below the maximum.

PEAK Mode (80350 Peak Power Sensor)

The Peak mode is for instantaneous peak measurements of the RF power level of a pulse modulated signal during pulse ON periods. The measurement is based on an instantaneous sample taken at a particular point in time. Sampling is triggered by a pulse rising edge either in the modulated signal itself or in a supplied trigger input signal, followed by a programmable delay. The trigger/delay combination makes it possible for you to specify exactly what part of the pulse is sampled.

In the peak mode, each displayed reading can consist of a single sample or of an average of multiple samples, each taken at the exact same time relative to the pulse's rising edge. If the averaging factor is set to 1, single samples are used. If it is other than 1, the averaging factor will determine the filter settling time over which the multiple samples will be taken and averaged.

Because the peak mode measures the RF power instantaneously (at the top of the pulse, provided that the delay has been set correctly), no assumptions are made about the pulse shape or duty cycle. In fact, it is possible to profile the pulse by sweeping the delay time over a range of values to reveal the pulse shape from start to finish.

☛ *NOTE:* In the peak mode the 8540C does not know where the peak is. It samples the pulse where it is told to sample the pulse whether or not the point sampled is really the peak point. This mode is therefore less intelligent than the BAP mode and must be used carefully, but its flexibility makes it a powerful tool for studying modulated signals.

Peak power measurements are made by sampling the RF input at a point which is defined by a trigger level, a delay, and a delay offset (see Figure 2-4). The initial triggering event occurs when the power input (or in the case of external triggering, a voltage input) reaches a threshold which you have defined as the trigger level. The sample is then taken after a delay which you have defined. To this delay can be added a positive or negative delay offset.

The delay offset is not necessary for peak measurement, but in some applications it is a convenience. For example, a small offset (even a negative offset) might compensate for the difference between the trigger

point and some other point of interest (such as the half-power point) especially in applications where pulse width is being measured. Or if it is necessary to measure the levels of various pulses within a pulse train, the pulses can be sampled successively by changing the delay. A fixed delay offset insures that each pulse is sampled at the same point in its cycle.

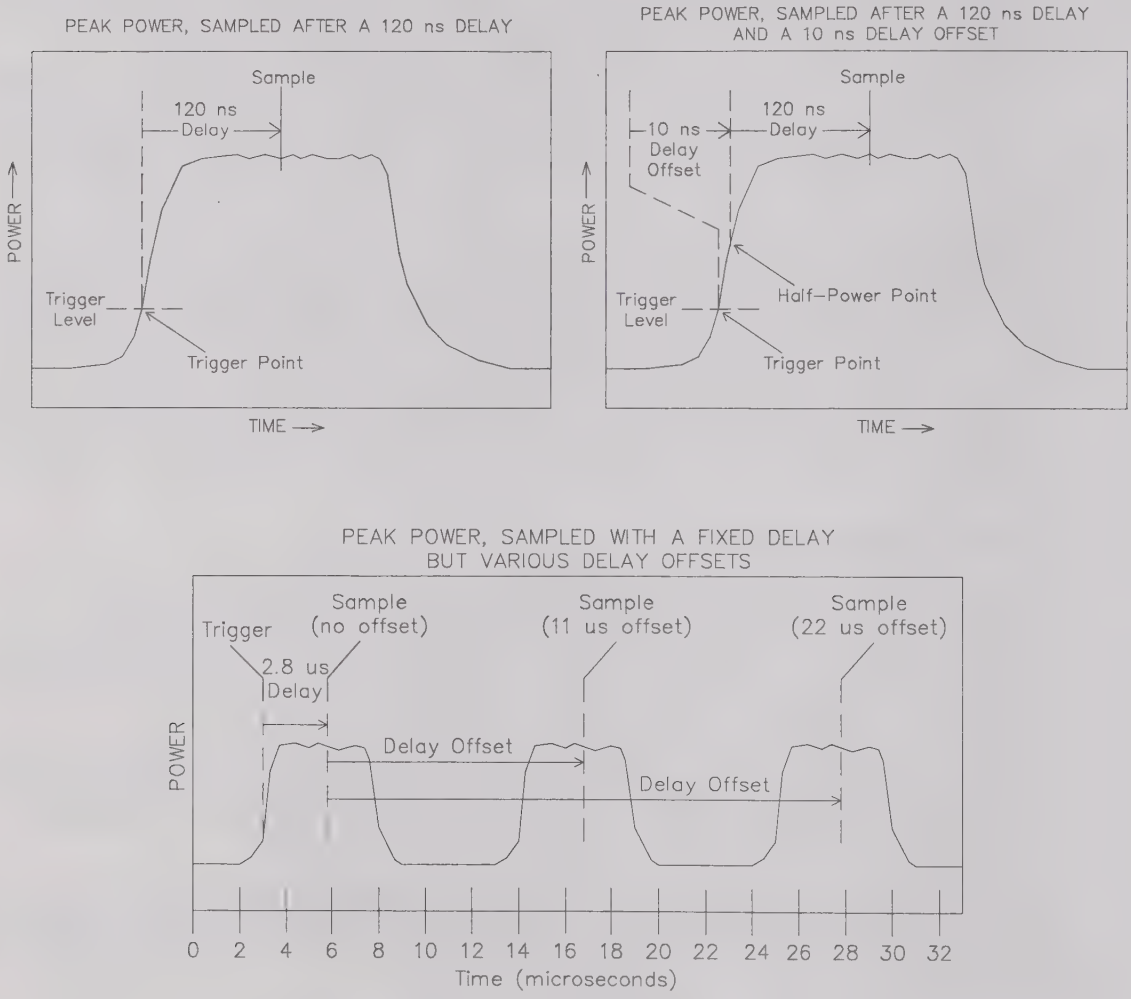


Figure 2-4. Delay and Delay Offsets

2.6.10 Mode Restrictions

In certain modes the 8540C has highly specific restrictions on its operation:

- In the fast measurement collection modes (swift and fast buffered), it is not possible to make measurements which compare the two channels. In other words, it is possible to make measurements using sensor A, or B, or both, but measurements such as A/B and A-B are not permitted.
- In GPIB remote operation, only one reading can be sent over the bus (it can be A, or B, or a comparative measurement such as A/B, but it is not possible for separate measurements of A *and* B to be sent over the bus). The exception is that in the swift and fast buffered measurement collection modes, it is possible for both A and B to be sent over the bus.

2.6.11 When to use CW, MAP, and BAP

For measuring signals with any kind of modulation, MAP mode should be used. In this mode, the 8540C makes use of its digital signal processing algorithms to ensure that the reading is the correct average power level regardless of modulation type (see Section B.2.2 for limits on modulation rate, etc.).

Of course, CW signals may also be accurately measured in MAP mode. This raises the question, why use CW mode? CW mode offers a few more dB of dynamic range at low power levels when using a CW power sensor, such as the 80301A. In addition, in CW mode the 8540C is form fit and function compatible with its predecessor, Model 8540.

BAP mode should be used only for the measurement of signals which are pulse modulated. In this mode the meter will accurately measure the average power of the signal during the on-time of the pulse. This mode works equally well regardless of whether the signal is modulated during the pulse on-time.

2.6.12 Multi-Tone Tests

Multi-tone testing refers to more than one RF carrier combined into one signal to be measured. Two-tone intermodulation testing, for example, is a common test performed on a wide variety of RF components and subsystems. MAP mode should be selected for these applications. The 8540C test procedure is as follows:

1. Calibrate the sensor according to the procedure outlined earlier in this section.
2. Press [MENU] and select Sensor Setup. Select Modulated Avg. and press [ENTER].
3. Press [FREQ] and enter the operating center frequency.
4. Connect the sensor to the multi-tone source and record the power level.

For two-tone testing, small errors in the measurement will result when the carriers are separated by more than about 50 kHz. The amount of error is also a function of average power level. For average power less than about -20 dBm, there is no modulation-induced measurement error at any tone separation. Consult the error charts found in Section B.2.2.

Multi-carrier testing usually refers to more than two carriers combined into one signal. Common multi-carrier tests combine 10 to 20 carriers. In determining expected measurement error for these types of signals, the maximum difference in frequency between any two carriers should be used as the tone separation when applying the error charts in the manual.

Another important feature of multi-carrier signals is that they can have a high peak-to-average power ratio. This ratio can be as high as 10 dB for ten carriers, for example. The significance of this in terms of making power measurements is two-fold. First, care should be taken to keep the peak power level applied to the sensor below the maximum recommended level. Second, when trying to minimize modulation-induced measurement error for carriers separated by more than 50 kHz, it is the peak power level that should be kept below about -20 dBm.

2.6.13 Peak Hold

When the Peak Hold feature is selected, the 8540C displays the highest instantaneous power measured from the time the feature is enabled until it is reset by the user. In other words, the displayed value tracks the measured value only when the measured value is rising to a new maximum. When the measured value falls, the displayed value holds at the maximum. When the peak hold feature is reset, the displayed value falls to the current measured value and the process begins again.

The Peak Hold feature is available in the MAP, PAP, and BAP measurement modes; it may be enabled from the front panel under the measurement setup menu, or over the GPIB. Peak Hold is reset by pressing [ENTER] (or, in remote control, by sending the command which activates the Peak Hold feature.

The reset function controls the time resolution of the reading (that is, for finer resolution, reset more frequently).

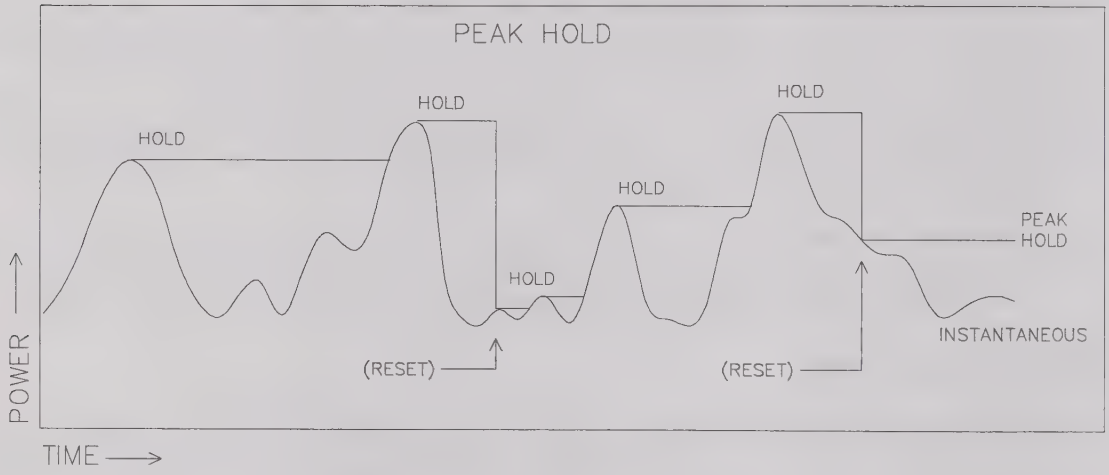


Figure 2-5. Peak Hold

2.6.14 Crest Factor

The Crest Factor feature is very similar to the peak hold feature, in that it holds on to the maximum level until a reset occurs, but in this case the displayed value is expressed (in dB) as a ratio of the held maximum power to the *average* power.

The Crest Factor feature is available in the CW, MAP, PAP, or BAP modes only. It can be enabled from the front panel under the measurement setup menu, or over the GPIB. The Crest Factor feature is reset by pressing [ENTER] or, in remote control, by sending the GPIB command which activates the Crest Factor feature (see Section 3.9).

In Figure 2-6, the same power input trace is used in two graphs to illustrate the effect of a drop in average power, with and without a reset. In the top graph, the power drop is followed by a reset. The held value drops to the current measured value, and the crest factor represents the ratio between the new maximum level and the new average level. In the bottom graph, there is no reset after the power drop, and the crest factor represents the ratio between the old maximum level and the new average level. For this reason, the crest factor feature should be reset after an input power level change.

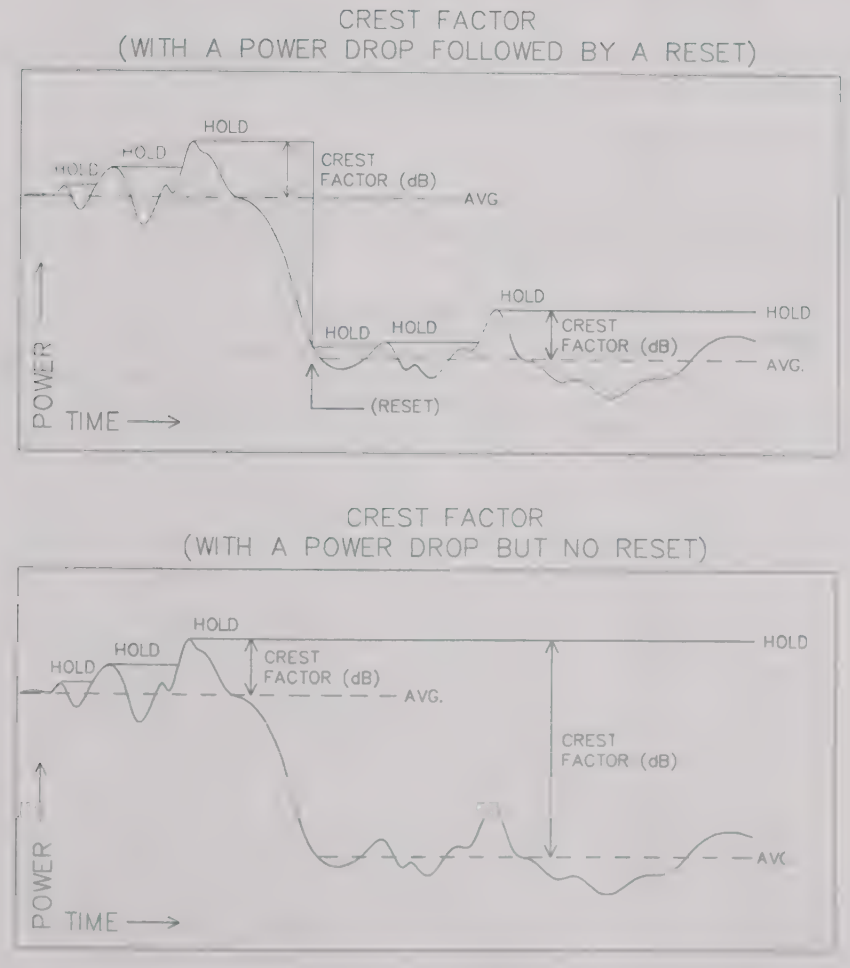


Figure 2-6. Crest Factor

2.6.15 Burst Signal Measurements

In a burst signal, the RF is pulsed on and off (i.e., pulse modulated). Often, the RF is modulated during the pulse on-time. Typical examples are TDMA digital cellular telephone formats such as NADC, JDC, and GSM. These formats and many others produce amplitude modulation of the RF during bursts.

Two types of power measurement can be made on these types of signals. If the total average power is desired, MAP mode should be used. Total average power includes both the off and on time of the pulses in the averaging. Often it is desired to know the average power just during the bursts. BAP mode makes this type of measurement very easy. The procedure is as follows:

1. Calibrate the sensor according to the procedure outlined earlier in this section.
2. Press [MENU] and select Sensor Setup. Select Burst Avg. and press [ENTER].
3. Press [FREQ] and enter the operating center frequency.
4. Connect the sensor to the burst signal source and record the power level.

The 8540C will automatically find the portions of the signal which are in the burst and include only those portions in the average.

Burst signals can have a high peak power-to-average power ratio depending on duty cycle. This ratio is proportional to the duty cycle and is given by:

$$10 \cdot \log\left(\frac{Duty\,Cycle\,[\%]}{100}\right)$$

This assumes no modulation during the burst. Modulation during the burst will increase this ratio by its own peak-to-average ratio. Due to this characteristic of burst signals, care must be taken to keep the peak power below the maximum rated input power of the sensor.

☛ ***NOTE:*** If the burst average power is too low or if the bursts are too narrow, the 8540C may lose sync with the bursts and fail to display the burst average power. When this happens, the BAP mode indicator on the front panel will flash and the meter will display total average power as in MAP mode. The conditions under which the 8540C may lose sync are listed in Section B.2.2.

2.6.16 Burst Start Exclude, Burst End Exclude

When measuring burst signals, it is sometimes desirable to mask the beginning or the end of a burst so that overshoot and other distortions do not affect the reading. For example, the GSM test specification for burst power measurements requires exclusion of the first 5% of the burst.

The Burst Start Exclude and Burst End Exclude features make it possible for BAP mode measurements to exclude the beginning or the end of a burst in this way. Both features can be used simultaneously, but this requires caution: if the excluded periods overlap, there is nothing left of the burst to be measured. If the entire burst is excluded, the BURST AVG LED on the front panel will flash, and the meter will revert to average measurement in the style of the MAP mode.

The duration of the excluded period is not specified directly; instead, the number of samples to be excluded is specified, which yields a guaranteed minimum exclude time of 90 µs × (n + .5), where n is the number of samples. The actual amount of time excluded may substantially exceed this minimum. In typical applications, it is sufficient to exclude one sample, which yields a guaranteed minimum exclude time of 135 µs.

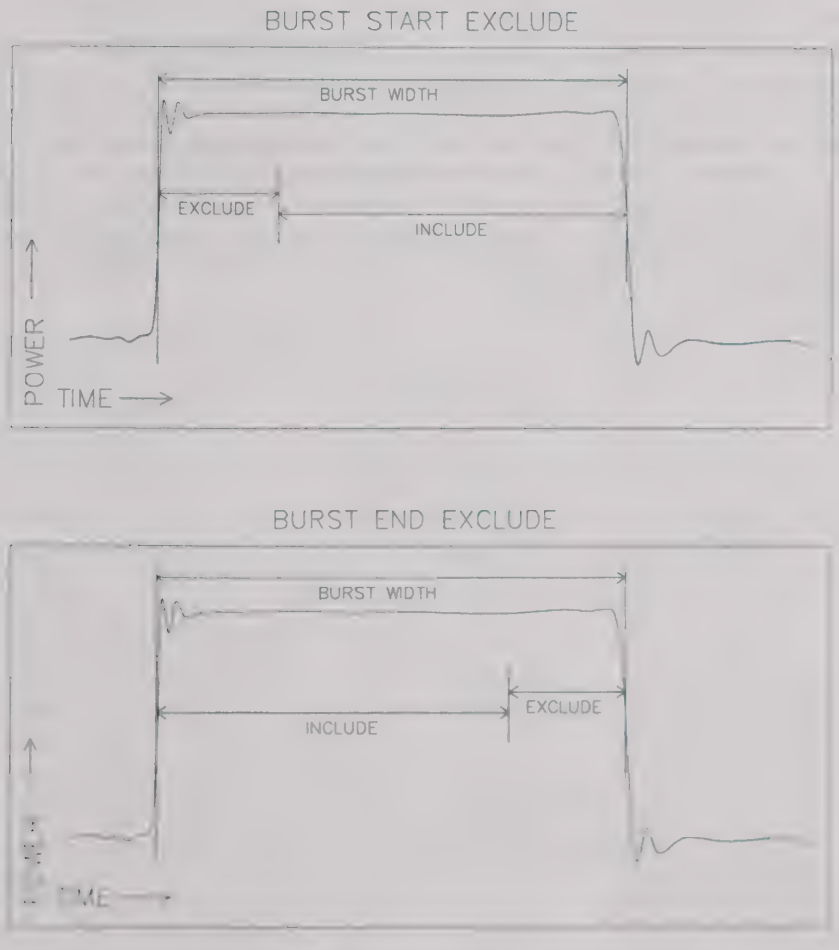


Figure 2-7. Burst Start Exclude & Burst End Exclude

2.6.17 Burst Dropout

In the BAP mode, average power is measured only during bursts. Because, in this mode, the bursts are automatically detected by the power meter, the user need not be aware of the burst repetition rate in order to make the measurement.

However, the BAP measurement algorithm defines bursts in a way which may be considered undesirable in some applications. In the example illustrated below, a 3.5 ms burst is followed by an OFF period of the same duration. During the burst, two brief dropouts occur. Normally, in BAP mode, each dropout would be interpreted as the end of a burst; the BAP algorithm would interpret the burst as three separate bursts, and the dropouts would be excluded from the average power measurement. As a result, the average power reading would be artificially raised.

When the Burst Dropout feature is enabled, the BAP algorithm is modified so that a dropout of sufficiently brief duration is not interpreted as the end of a burst. In the example below, dropout time is specified at 350 µs. The two dropouts which occur during the burst have a duration of less than 350 µs; therefore the entire burst is interpreted as a single burst, and the dropouts are included in the average power measurement. The 3.5 ms OFF period following the burst is interpreted as the end of the burst, because it exceeds 350 µs in duration.

This feature must be configured and interpreted with care. The dropout time is selected from a series of discrete values (.17 ms, .26 ms, .35 ms, and so on up to 31.96 ms); however, these are only the guaranteed minimum values. In practice, the BAP algorithm may tolerate dropouts up to 2.15 times as long as the minimum value. Therefore, the time between bursts must be at least 2.2 times as long as the selected dropout time (because, if the time between bursts is less than the tolerated dropout time, the BAP algorithm never recognizes the end of a burst, and the signal is simply averaged, as if the MAP mode had been selected). Also, dropouts occurring at the end of a burst are a problem, because the BAP algorithm cannot distinguish them from the end of the burst itself; there should be at least 250 µs of burst remaining after the last dropout within that burst.

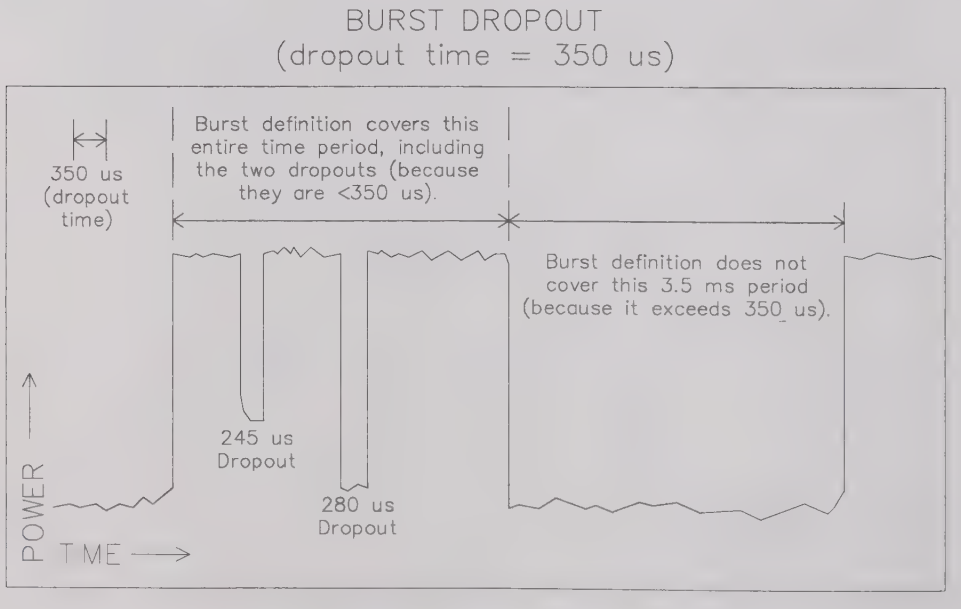


Figure 2-8. Burst Dropout

2.6.18 Optimizing Measurement Speed

In many power measurement situations, measurement speed is defined in terms of settling time following a step change in average power. In other words, it is desired to know the average power level within some specified tolerance as quickly as possible following a power level change. This is often accomplished by setting up the power meter in free-run mode over the GPIB and monitoring the collected measurement data with the host computer until it falls within the predetermined tolerance window.

The Auto average feature of the 8540C eliminates the need for the host computer to do any data monitoring and can be set up to automatically output measurement data when it has settled to within the specified tolerance. This is done by triggering each measurement with a TR2 command and waiting for the meter to signal the host with an SRQ. The SRQ is asserted and the data is put on the bus as soon as the power measurement has averaged long enough to be within the specified tolerance.

The tolerance is specified by including the measurement settling tolerance parameter with an FA command (Auto average on). This parameter is specified in terms of percentage. For example, if a measurement settling tolerance of 1% is specified, the 8540C Auto average algorithm will specify an averaging time just long enough so that the result put on the bus is within ±0.5% (that is, ±0.02 dB) of the average power. Thus, the settled measurement data is available on the bus in the minimum time necessary to be within the specified tolerance.

The tolerance specified in the FA command is a *target* tolerance. For example, it is possible that the peak-to-peak power variation of the signal being measured is so great that the maximum averaging time of 20 seconds is not long enough to reduce the variation to within the specified tolerance. It is also possible that the rate of power variation is so slow that more than 20 seconds of averaging is required. In these cases, further averaging would have to be done by the host computer.

The following example program shows how to set up a triggered measurement, optimized for speed using the auto averaging feature:

```
Tr2:                              ! Read using TR2 command
ON INTR 7 GOSUB Srq_interrupt     ! Set up SRQ interrupt
ENABLE INTR 7                     ! Enable SRQ interrupt
OUTPUT 713;*SRE41                 ! Set service request mask
OUTPUT 713;CS                     ! Clear status byte
OUTPUT 713;TR2                    ! Trigger measurement
Data_ready=0                      ! Clear flag
WHILE Data_ready=0                ! Wait for data ready
END WHILE
RETURN
Srq_interrupt:                    ! SRQ jumps here
State=SPOLL(713)                  ! Get status byte
IF BIT(State,0) THEN              ! If the Data Ready bit is set...
   Data_ready=1                   ! Set the flag
   ENTER 713;Tr2_reading          ! Read the measurement
   OUTPUT 713;CS                  ! Clear the status byte
   OUTPUT 713;*SRE0               ! Clear the service request mask
   END IF
RETURN
```

2.6.19 Peak Power Measurements

Peak power sensors directly measure the amplitude of pulsed microwave signals. The direct sampling technique is more accurate than traditional duty cycle correction methods. The sample position can be displayed on an oscilloscope.

1. Calibrate a peak power sensor and connect it to a pulsed microwave source.
2. Press [MENU]. Go to the Sensor Setup menu, and select internal, external, or CW triggering.
3. Select the desired trigger level (for internal or external triggering).
4. Select the desired sample delay (for internal or external triggering).
5. Optionally, set the desired delay offset (for internal or external triggering).
6. Connect the peak power sensor's Detector Out to an oscilloscope to view the sample position. For 80350A Peak Power Sensors, also connect the sensor's Sample Delay output to the oscilloscope and trigger on that channel.

2.6.20 Measuring an Attenuator (Single Channel Method)

Attenuators are useful for many applications. With the 8540C, attenuators can be calibrated quickly and accurately. The single channel calibration procedure outlined below is efficient for calibrating at a single frequency or at a limited number of frequencies.

1. Connect the power sensor to the signal source through a 6 dB attenuator (a matching pad) and adjust the source output power to about 0 dBm. Verify that the source output is stable.
2. Press [FREQ]; enter the operating frequency (this step is optional).
3. Press the REL button to set the reference level.
4. Insert the attenuator to be calibrated between the matching pad and the power sensor.
5. Record the attenuator value.

2.6.21 Improving Accuracy

Mismatch uncertainty is the largest source of error in power measurement. The 6 dB pad that is used in the attenuator calibration procedure above reduces mismatch uncertainty by effectively improving the return loss (or reducing the SWR) of the source.

Mismatch uncertainty is large when a device has a poor impedance match relative to 50 Ω.

Poorly matched devices reflect a large proportion of incident signals and create standing waves along the transmission line. At various points along the transmission line, the standing wave will be at maximum or minimum amplitude. Mismatch uncertainty is a measure of the deviation between these maxima and minima.

Inserting an attenuator into the transmission line reduces mismatch uncertainty by reducing the amplitude of the reflected signal, thereby reducing the difference between a standing wave's maximum and minimum levels.

Compared to an attenuator, most microwave sources have poor impedance matching. Using the 6 dB attenuator during the calibration has the effect of lowering the SWR of the microwave source. The only compromise is a corresponding 6 dB reduction in the source's dynamic range when the 6 dB attenuator is attached.

2.6.22 Comparing Accuracy to a Traceable Standard

Verifying accuracy and calibrating test equipment are essential to microwave engineers and technicians. Accurate, repeatable measurements are required for validating designs, certifying calibrations, making engineering decisions, approving product components, certifying standards, and verifying performance specifications.

1. A 6 dB attenuator is placed at the input port of a power splitter to provide a good impedance match from the source. This effectively reduces the VSWR of the source. Depending on the signal quality of your source over frequency, additional attenuation may be desirable. A two resistor power splitter provides consistently matched power levels at its output ports, X and Y. The largest sources of error are power splitter tracking errors and mismatch uncertainty.
2. Connect the reference standard power meter to power splitter output X, and the power meter to be verified to splitter output Y.
3. Adjust the source frequency to a standard reference frequency (50 MHz for most power meters).
4. Enter the operating frequency or frequency cal factors into the power meters.
5. Adjust the source amplitude to the maximum sensor operating level (+20 dBm for standard sensors).
6. Zero each power meter and record the measurement values immediately after settling.
7. Adjust the source for +19 dBm output level and repeat Step 6.
8. Continue testing at 1 dB increments through the rest of the standard sensor's 90 dB dynamic range.
9. Calculate measurement uncertainty and compare the measured results to the specified tolerances.

At low power levels, be sure to zero the sensor prior to taking measurements. At levels below -55 dBm, the measurements should be recorded just after zeroing is completed. The zeroing process must be repeated periodically, depending on the operating level, due to drift characteristics.

2.6.23 Sources of Error

In the previous accuracy verification procedure, there are four sources of error:

- Source output level variation
- Power splitter output tracking
- Power meter X total measurement uncertainty
- Power meter Y total measurement uncertainty

Worst case uncertainty, which should be used for calibration purposes, is the arithmetic sum of all four of these sources of error.

Source output level variation occurs in all microwave sources. This happens when the signal source output level changes during the time it takes to record the displayed value on power meter X and then to read the displayed value on power meter Y. This source of error can be minimized by using a laboratory grade signal source.

Power splitter output tracking errors are the maximum signal level variation at the splitter X output as compared to the splitter Y output.

Total measurement uncertainty for each of the power meters is the worst case combination of mismatch uncertainty, instrument accuracy, and sensor accuracy.

Mismatch uncertainty is calculated from the reflection coefficients of the sensor and the splitter (source) according to the following formula:

$$M\,(dB) = 20 \log_{10} [1 \pm (\rho_{SENSOR})\,(\rho_{SOURCE})]$$

$$\text{where } \rho = \frac{VSWR - 1}{VSWR + 1}$$

For a source mismatch specified in terms of return loss (RL), the equation should be modified according to:

$$\rho_{SOURCE} = 10^{r}$$

$$\text{where } \rho = \frac{-RL\,(dB)}{20}$$

The following factors affect instrument accuracy:

- Instrument linearity or instrumentation uncertainty
- Reference calibrator settability or power reference uncertainty

The following factors affect sensor accuracy:

- Calibration factor uncertainty
- Calibrator to sensor (or power reference to sensor) mismatch uncertainty
- Noise
- Zero set
- Calibration pad uncertainty (for thermal-based power meters only)
- Sensor linearity

3

Remote Operation

3.1 Introduction

The 8540C permits data control over the General Purpose Interface Bus (GPIB) in accordance with IEEE Standard 488-1978, *Digital Interface for Programmable Instruments*. Table 3-1 shows which functions of the standard are implemented in the 8540C.

Table 3-1. Implemented IEEE Standards

Function	8540C Implementation
Source Handshake	SH1 (complete capability)
Acceptor Handshake	AH1 (complete capability)
Talker	T5 (basic talker, serial poll, talk only mode, unaddressed if MLA)
Extended Talker	TE0 (no capability)
Listener	L3 (basic listener, listen only mode, unaddressed if MTA)
Extended Listener	LE0 (no capability)
Service Request	SR1 (complete capability)
Remote/Local	RL1 (complete capability)
Parallel Poll	PP1 (remote configuration)
Device Clear	DC1 (complete capability)
Device Trigger	DT1 (complete capability)
Controller	C0 (no capability)

3.1.1 Sending Commands to the 8540C

The Giga-tronics 8540C Series Power Meters use standard protocols for communication over the GPIB. Commands conform to the IEEE-488.1 or IEEE-488.2 guidelines. Three emulation modes (436, 437, and 438) are available for users of older power meters who cannot rewrite their application software.

The program examples shown in this chapter are written in HTBasic™ format (HTBasic is a trademark of TransEra Corporation). Other languages would use different commands but the string that is sent or received will always be the same. In HTBasic, the OUTPUT command sends a string to the GPIB. The number after the word OUTPUT is the GPIB address of the instrument.

The factory-set default address of the 8540C is 13 and the address of the GPIB is assumed to be 7; therefore, examples of command strings in this manual are preceded by OUTPUT 713;.

The GPIB address can be set from the front panel to any number from 0 to 30. GPIB address 40 will set the instrument to the listen only mode. Address 50 sets the instrument to the talk only mode. To change the GPIB operating mode or address, enter the menu system with the MENU key. Select the SETUP menu using the up/down arrow keys. ENTER this sub menu system and select the GPIB setup menu key. The operating mode and GPIB address can be set in the GPIB setup menu using the arrow keys. Press ENTER to save your selection or press ESCAPE (the menu key) to exit without saving.

3.1.2 Clear Device

The interface command CLEAR 713 may be used to reset the GPIB and set the 8540C to its preset condition.

3.1.3 Clear Interface

The interface command ABORT 7 may be used to reset the GPIB without setting the 8540C to its preset condition. The 8540C will not be addressed after the abort.

3.1.4 Local & Remote Control

The interface command LOCAL 713 may be used to place the 8540C in the local control mode. When the 8540C is in local mode, the front panel REMOTE LED is off and all front panel keys are enabled.

The interface command REMOTE 713 may be used to place the 8540C in the remote control mode. When the 8540C is in remote mode, the front panel REMOTE LED is on and all front panel keys except the ENTER key are disabled. Press the ENTER key to return the instrument to local mode.

The interface command LOCAL LOCKOUT 7 may be used to place the 8540C in the local lockout mode. This is a remote control mode in which all of the 8540C front panel keys including the remote control mode are disabled. The GPIB LOCAL command must be issued in order to return the 8540C to local mode (disconnecting the GPIB cable will also return the instrument to local mode).

3.1.5 Sensor Selection and Calibration

Power sensor selection data, specifications, and calibration (local and remote) are contained in Appendix B of this manual.

3.1.6 Polling

The GPIB supports parallel and serial polling. The example programs below show how to use the parallel and serial poll capabilities of the 8540C to determine when a requested zeroing operation is completed.

Parallel Polling

```
Ppoll_zero:                          ! zero using parallel poll
PRINT entering parallel poll zero routine
PPOLL CONFIGURE 713;8                ! configure response on bit zero
OUTPUT 713;CSAEZE                    ! clear status byte, zero channel A
State=0                              ! initialize variable
WHILE State 1                        ! stay here until zero done
   State=PPOLL(7)                    ! read the poll
   END WHILE
PPOLL UNCONFIGURE 713                ! cancel parallel poll mode
PRINT parallel zero done
RETURN
```

Serial Polling

```
Srq_zero:                            ! zero with an srq interrupt
PRINT entering SRQ interrupt zero routine
ON INTR 7 GOSUB Srq_interrupt
OUTPUT 713;CS                        ! clear status byte
ENABLE INTR 7;2                      ! enable srq interrupts
OUTPUT 713;@1;CHR$(2)                ! enable srq handshake
OUTPUT 713;AEZE                      ! execute zero command
Flag=0                               ! test flag reset to false
WHILE Flag=0                         ! stay here until test flag set true
   WAIT 1
   PRINT Still inside while loop
END WHILE
PRINT SRQ interrupt zero done
RETURN
Srq_interrupt:                       ! SRQ interrupts jump here
PRINT an SRQ interrupt has occurred
OUTPUT 713;CS                        ! clear status byte
Flag=1                               ! set control flag true
RETURN
```

3.1.7 Data Output Format (Standard Measurement Collection Mode)

The data output format is as follows:

±D.DDDDE±NNCRLF

±:	Sign of the Mantissa
D.DDDD:	Mantissa (5 digits)
E:	Exponent (indicates that an exponent follows)
±:	Sign of the Exponent
NN:	Magnitude of the Exponent
CR:	Carriage Return
LF:	Line Feed

3.1.8 Data Output Formats (Fast Measurement Collection Modes)

Data output formats for the swift mode and fast buffered mode differ from the format described above. Data is expressed in the form of a signed five-digit number, with two digits to the right of the decimal, and no exponents. In some cases, multiple values are sent:

One sensor swift mode:	±DDD.DD CRLF
Two sensor swift mode:	±DDD.DD, ±DDD.DD CRLF
Fast buffered mode:	±DDD.DD, ... ±DDD.DD CRLF

3.1.9 Power-on Default Conditions

The interface wake-up state is as follows:

GPIB Local Mode
Unaddressed, Service Request Mask Cleared
Status Byte Cleared
TR3 Free Run Trigger Mode Set
GT2 Group Execute Trigger Mode Set
Parallel Poll Data Line Unassigned
Display Enabled
Service Request Mask Cleared
Event Status Register = 128
Event Status Mask Clear

3.2 Command Syntax

The elements of the 8540C interface commands are introduced below. The discussion is general. Because some commands are included for the sake of compatibility with earlier models, there are some variations in syntax from one command to another which must be carefully accommodated.

3.2.1 Functions

At a minimum, the interface command includes a function code. The function indicates the nature and purpose of the command. Some commands contain a function code and nothing else. For example, the function AP, which causes the 8540C to measure power using the A sensor, stands alone as a command. Commands which consist only of a function code are referred to in this manual as simple commands. However, most commands consist of a function code combined with other elements.

Functions are listed alphabetically in the Command Set tables (see Section 3.3).

3.2.2 Prefixes

Some commands must begin with a prefix that identifies the sensor to which the command applies. For example, function code ZE (which causes a sensor to be zeroed) must be combined with a prefix in order to specify which sensor is zeroed. The full command is either AE ZE (for sensor A) or BE ZE (for sensor B).

Many of the commands described in this chapter are stated to require an AE or BE prefix, which specifies the sensor that will be affected by the command. In some situations, the prefix can be omitted.

When the 8540C receives a command containing a sensor-specific prefix, it assumes that all subsequent commands refer to the same sensor until a command is received which specifies the other sensor. Therefore, if a command prefixed by AE is received, subsequent commands can omit the prefix provided that they are intended for Sensor A.

Because Model 8541C supports only one sensor, the AE and BE prefixes can be omitted from any command issued to that model.

It does no harm to include the prefix even when it is superfluous; some users may find that the most convenient approach is to include the prefix in all applicable commands.

3.2.3 Variables

Some commands must include one or more variables to specify quantities or options for the command. For example, the function code ANALOG (which is used in commands that configure the analog output) is combined with many different variables to specify different aspects of the analog output. In the command

ANALOG STD TOP LOG -80.0, 20.0, 0.0, 10.0

the variables are interpreted as follows:

STD	Specifies the standard analog output (as opposed to the optional second output).
TOP	Specifies the top line of the display.
LOG	Specifies that power is to be measured in logarithmic units (that is, dB or dBm).
-80.0	Specifies that the low end of the analog output voltage range represents -80 dBm in.
+20.0	Specifies that the high end of the analog output voltage range represents +20 dBm in.
0.00	Specifies that the low end of the analog output range is 0 volts.
10.0	Specifies that the high end of the analog output range is 10 volts.

In the above example, the numeric variables are strung together, with separator characters between them (see Separators below). However, in some commands, numeric variables are preceded in the command string by the variable name. For example, in the command FBUF PRE TTL BUFFER 200 TIME 1300, the numeric variables known as buffer and time are identified by name within the string.

Many variables are qualitative rather than quantitative; they select from among the various modes or options available for a particular function.

3.2.4 Suffixes

Some commands require a terminating suffix. For example, the function code DY specifies a duty cycle. It requires an AE or BE prefix (to indicate which channel is meant), and a numeric variable (to indicate the duty cycle as a percentage). Finally, the command must include a terminating suffix (the choices of suffix in this case are EN, PCT, and %). The command AE DY 50 % sets the duty cycle for channel A to 50 percent.

☛ **NOTE:** Some commands that include numeric variables require a terminating suffix. However, many other commands do not require terminating suffixes, and interface problems will occur if the suffixes are used in commands which don't need them. Each command must be used so that its particular syntax requirements are met.

3.2.5 Separators

Spaces, commas, colons, and semicolons can be used as separators between the various elements of a command (function codes, variables, etc.). Commands are usually spelled out in this manual with spaces inserted between the elements (for example, SWIFT PRE GET BUFFER 100), for the sake of readability. Although separators within a command are permitted, they are usually not required; in the command descriptions in this chapter (beginning with Section 3.4), required separators are noted.

3.2.6 Command Format Illustrations

A command format is used in this chapter to show the possible elements of a command, as shown below:

[AE or BE] DY [n] [EN or PCT or %]

Variables are shown within brackets. In this example, the prefix can be AE or BE, the function is DY, a numerical variable [n] follows the function, and the suffix at the end can be EN, PCT, or %.

Possible commands which use this example format include AE DY 42 % and BE DY 29.5 EN.

3.3 Series 8540C Command Codes

3.3.1 IEEE-488.2 Common Commands

Table 3-2 lists the IEEE-488.2 common commands that are implemented in the 8540C. For further information refer to the manual sections cited in Table 3-2.

Table 3-2. IEEE-488.2 Command Set

Command	Description	Section
*CLS	Clear status byte	3.30.1
*ESE	Set Event Status Enable Register	3.30.2
*ESE?	Ask for current status of Event Status Enable Register	3.30.2
*ESR?	Ask for and clear Event Status Register bits	3.30.2
*RST	Software reset	3.26
*STB?	Ask for status byte	3.30.1
*SRE	Set the service request mask	3.30.1
*SRE?	Ask for service request mask	3.30.1
*IDN?	Ask for instrument ID	3.14

3.3.2 8540C Function Codes

Table 3-3 lists the function codes that are applicable when the instrument is in the 8541C mode or the 8542C mode. Most of these codes do not stand alone; commands; prefixes, variables, and suffixes must be combined with them. For further information refer to the manual sections cited in Table 3-3.

Table 3-3. 8540C Function Codes

Code	Description	Section
@1	Set service request mask	3.30.1
@2	Set learn mode 2 data	3.15.2
?ID	Ask for instrument ID	3.14
AD	Measure A-B	3.29
ANALOG	Configure analog output	3.4
AP	Measure sensor A	3.29
AR	Measure A/B	3.29
BAP	BAP mode	3.19.4
BD	Measure B-A	3.29
BP	Measure sensor B	3.29
BR	Measure B/A	3.29
BSPE	Burst end exclude	3.20
BSTE	Burst start exclude	3.20
BTDP	Burst dropout	3.20.3
CL	Calibrate sensor	3.7
CRF	Ask for crest factor value	3.9
CR	Crest factor	3.9
CS	Clear status byte	3.30.1
CW	CW mode	3.19
DA	Test LEDs	3.10
DC0	Duty cycle disable	3.11
DC1	Duty cycle enable	3.11
DD	Display disable	3.10
DE	Display enable	3.10
DU	Display user message	3.10
DY	Set duty cycle	3.11
EEPROM	Sensor EEPROM query	3.12
FA	Auto averaging	3.5
FBUF	Fast buffered mode	3.18.3
FH	Hold current averaging number	3.5.1
FM	Set averaging number	3.5.2
FMOD	Fast modulated mode	3.18.5
FR	Frequency	3.13
GT0	Cancel GET	3.17.2
GT1	GET single measurement	3.17.2
GT2	GET full measurement with settling	3.17.2
ID	Ask for instrument ID	3.14
KB	Enter cal factor	3.6
LG	Log units (dB or dBm)	3.32

Code	Description	Section
LH	Set high limit	3.16
LL	Set low limit	3.16
LM0	Disable limit checking	3.16
LM1	Enable limit checking	3.16
LN	Linear units (Watts or %)	3.32
LP1	Ask for learn mode #1 string	3.15.1
LP2	Ask for learn mode #2 output	3.15.2
MAP	MAP mode	3.19
MAX	Ask for max value	3.21
MEAS	Ask for measurement mode	3.19.6
MIN	Ask for minimum value	3.21
MN0	Min/max disable	3.21
MN1	Min/max enable	3.21
OC0	Disable calibrator source	3.8
OC1	Enable calibrator source	3.8
OF0	Offset disable	3.22
OF1	Offset enable	3.22
OS	Set offset value	3.22.2 & 3.22.3
PAP	PAP mode	3.19
PEAK	Peak sensor settings	3.24 & 3.25
PH	Peak hold	3.23
PKH	Ask for peak hold value	3.23
PR	Preset the 8540C	3.26
RC	Recall a saved instrument state	3.31
RE	Display resolution	3.28
RL0	Disable relative measurement	3.27
RL1	Enable relative measurement	3.27
RL2	Use old reference for relative measurement	3.27
RV	Ask for service request mask	3.30.1
SM	Ask for status message	3.30.3
ST	Store instrument state	3.31
SWIFT	Swift mode	3.18.4
TR0	Trigger hold mode	3.17
TR1	Trigger single measurement	3.17
TR2	Trigger full measure with settling	3.17
TR3	Free run trigger mode	3.17
VPROPF	Configure VpropF feature	3.33
ZE	Sensor zeroing	3.34

3.3.3 437 Emulation GPIB Command Set

These are the GPIB commands that are available when the instrument is placed in the 437 emulation mode. Footnotes appear at the end of Table 3-4.

Table 3-4. 8540C Command Set for 437 Emulation

Command	Description
CL	CAL[1]
*CLS	Clear all Status Registers[2]
CS	Clear the Status Byte
CT0 - CT9	clear sensor data tables 0 thru 9 [ignored]
DA	All display segments on
DC0	Duty Cycle on
DC1	Duty Cycle off
DD	Display disable
DE	Display enable
DN	down arrow emulation [ignored]
DU	Display user message
DY	Duty Cycle (enter duty cycle value)
ERR?	device error query
*ESE	set the event status enable mask[3]
*ESE?	event status register enable mask query[3]
*ESR?	event status register query[3]
ET0 - ET9	edit sensor cal factor table 0 thru 9 [ignored]
EX	exit [ignored]
FA	automatic filter selection
FH	filter hold
FM	manual filter selection[1]
FR	frequency entry
GT0	ignore Group Execute Trigger (GET) bus command
GT1	trigger immediate response to GET command
GT2	trigger with Delay response to GET command
ID	GPIB identification query
*IDN?	GPIB identification query[2]
KB	Cal Factor[1]
LG	Log display
LH	High limit[1]
LL	Low limit[1]
LM0	Disable limits checking function
LM1	Enable limits checking function
LN	Linear display
LP2	437 learn mode
LT	Left arrow [ignored]
OC0	Reference oscillator off

Command	Description
OC1	Reference oscillator on
OD	Output display text [ignored]
OF0	Offset off - Local
OF1	Offset on - Local
OS	Offset (enter offset value)
PR	Preset
RA	Auto range[4]
RC	Recall[1]
RE	Resolution[1]
RF0 - RF9	Enter sensor ref cal factor [ignored]
RH	Range hold[4]
RL0	Exit REL mode
RL1	Enter REL mode using REL value
RL2	Use old ref number
RM	Set range[1, 4]
*RST	Soft reset
RT	Right arrow [ignored]
RV	Read Service Request Mask value
SE	Sensor [ignored]
SM	Status Message
SN0 - SN9	enter sensor serial number [ignored]
SP	Special [ignored]
*SRE	Set the Service Request Mask value[2]
*SRE?	Service Request Mask query
ST	Store instrument state
*STB?	Read the Status Byte
TR0	Trigger hold
TR1	Trigger immediate
TR2	Trigger with delay
TR3	Trigger - free run
*TST?	Self test query
UP	Up arrow [up arrow]
ZE	Zero
@1	Prefix for Status Mask
@2	Learn mode prefix

Notes:

1. A numeric entry is required by these GPIB codes, followed by the code EN (ENTER).
2. This GPIB code uses the next 6 characters (0-9, A-Z, or an underscore) as input data.
3. The asterisk (*) must be included as part of the GPIB command string.
4. The 8540C can always measure over its entire dynamic range; there is no need to specify the range. Therefore, range related commands have no effect on the measurement capability of the 8540C. The auto range, range hold, and set range commands only offset the analog output voltage, and only in 436, 437, or 438 GPIB emulation modes. In these emulation modes (when using a single sensor, and not measuring in a relative mode), the power will be scaled to a range of 0 to 1 volts, representing the relative power within the current 10 dB range of the 8540C. The range hold and set range commands will simulate locking the range of power represented by the output voltage.

3.3.4 438 Emulation GPIB Command Set

These are the GPIB commands that are available when the instrument is placed in the 438 emulation mode. Footnotes appear at the end of Table 3-5.

Table 3-5. 8540C Command Set for 438 Emulation

Command	Description
?ID	Ask for ID (the old way)
@1	Prefix for Service Request Mask
@1;CHR$(4)	Set Service Request Mask to 4
AD	Measure A-B
AP	Measure sensor A
AR	Measure A/B
BD	Measure B-A
BP	Measure sensor B
BR	Measure B/A
CL[1]	Calibrate sensor (precede with AE or BE)
CS	Clear status byte
DA	Display all
DD	Display disable
DE	Display enable
FA	Set auto average filtering (precede with AE or BE)
FH	Hold present average number (precede with AE or BE)
FM	Set averaging number
GT0	Group execute trigger cancel
GT1	Group execute trigger single measurement
GT2	Group execute trigger full measurement with settling
KB	Cal Factor
LG	Set Log units (dB or dBm)
LH	High limit
LL	Low limit
LM0	Disable limit checking
LM1	Enable limit checking
LN	Set linear units (Watts or %)
LP1	Set learn mode #1
LP2	Set learn mode #2
OC0	Turn off calibrator source
OC1	Turn on calibrator source
OS	Offset
PR	Preset the instrument to a known state
RA[2]	Resume autorange [not supported]

Command	Description
RC	Recall previous instrument state
RH[2]	Do a range hold
RL0	Turn off rel mode
RL1	Turn on rel mode
RM[2]	Set manual range
RV	Ask for status request mask
SM	Ask for status message
ST	Store instrument state
TR0	Trigger hold mode
TR1	Trigger single measurement
TR2	Trigger full measurement with settling
TR3	Free run trigger mode
ZE	Zero sensor (precede with AE or BE)

Notes:

1. A numeric entry is required by these GPIB codes, followed by the EN suffix.
2. The 8540C is always able to measure over its entire dynamic range; there is no need to specify the range. Therefore, range-related commands have no effect on the measurement capability of the 8540C. The auto range, range hold, and set range commands only offset the analog output voltage, and only in 436, 437, or 438 GPIB emulation modes. In these emulation modes (when using a single sensor, and not measuring in a relative mode), the power will be scaled to a range of 0 to 1 volts, representing the relative power within the current 10 dB range of the 8540C. The range hold and set range commands will simulate locking the range of power represented by the output voltage.

3.3.5 436 Emulation GPIB Command Set

Table 3-6 lists the GPIB commands that are available when the instrument is placed in the 436 emulation mode:

Table 3-6. 8540C Command Set for 436 Emulation

Command	Description
5[1]	Set range 5
4[1]	Set range 4
3[1]	Set range 3
2[1]	Set range 2
1[1]	Set range 1
9[1]	Set auto range
A	Set linear units (Watts)
B	Set relative mode
C	Set relative value
D	Set Log units (dBm)
Z	Zero sensor
+	Enable cal factors
-	Disable cal factors (ignored)
H	Set TR0 mode
T	Set TR2 mode
I	Set TR1 mode
R	Set TR3 mode
V	Set TR3 mode

Notes:

1. The 8540C is always able to measure over its entire dynamic range; there is no need to specify the range. Therefore, range-related commands have no effect on the measurement capability of the 8540C. The auto range, range hold, and set range commands only offset the analog output voltage, and only in 436, 437, or 438 GPIB emulation modes. In these emulation modes (when using a single sensor, and not measuring in a relative mode), the power will be scaled to a range of 0 to 1 volts, representing the relative power within the current 10 dB range of the 8540C. The range hold and set range commands will simulate locking the range of power represented by the output voltage.

   In 436 emulation, the specified range is also indicated in the power data strings returned to the host.

3.4 Analog Output

3.4.1 Standard Output

Commands relating to the standard analog output (that is, the rear panel analog output which is installed in all instruments, not the optional second output) are based on the ANALOG function code, as described below.

Enabling and Disabling the Output

The ANALOG function can enable or disable the analog output. The command format for this purpose is:

ANALOG STD STATE [ON or OFF]

STD indicates that the standard analog output (not the optional output) is being configured.

STATE indicates that the analog output ON/OFF status is being configured.

The variables ON and OFF indicate whether the analog output is to be enabled or disabled.

Examples:

```
OUTPUT 713;ANALOG STD STATE ON     ! Enable analog output
OUTPUT 713;ANALOG STD STATE OFF    ! Disable analog output
```

Setting Options for the Output

The ANALOG function can also configure various aspects of the analog output. The command format is:

ANALOG STD [TOP or BOT] [LG or LN] [a b c d]

STD indicates that the standard analog output (not the optional output) is being configured.

[TOP or BOT] specifies the top or bottom line of the display.

[LG or LN] specifies logarithmic (dBm) or linear (Watts) measurement.

The command string ends with four numeric variables (with at least one separator character between each pair of them), which define the relationship between the input power range and the output voltage range:

a: the power level represented by the minimum output voltage,
b: the power level represented by the maximum output voltage,
c: the minimum output voltage,
d: the maximum output voltage.

Valid power range numbers are -100 to +100 [dBm] for LOG, or 0 to 1E15 [Watts] for LIN. Valid voltage range numbers are 0.00 to +10.00 [VDC].

Examples:

```
OUTPUT 713;ANALOG STD TOP LOG -80.0, 20.0, 0.0, 10.0
                                   ! Configure the analog output top line display channel as
                                   ! follows:
                                   ! logarithmic units, -80 to +20 dBm input, 0 to 10 volt output
OUTPUT 713;ANALOG STD BOT LIN 0.00, 1.00E-3, 0.0, 1.0
                                   ! Configure the analog output bottom line display channel as
                                   ! follows:
                                   ! linear units, 0 to 1.00 mW, 0 to 1 volt output
```

3.4.2 Optional Second Output

Commands relating to the optional second analog output (also see Option 06 in Appendix C) are based on the ANALOG function code, as described below.

Enabling and Disabling the Output

The ANALOG function can enable or disable the optional analog output. The command format for this purpose is:

ANALOG OPT STATE [ON or OFF]

OPT indicates that the optional second analog output is being configured.

STATE indicates that the analog output ON/OFF status is being configured.

[ON or OFF] indicate whether the analog output is to be enabled or disabled.

Examples:

```
OUTPUT 713;ANALOG OPT STATE ON    ! Enable second analog output
OUTPUT 713;ANALOG OPT STATE OFF   ! Disable second analog output
```

Setting Options for the Output

The ANALOG function can also control various other aspects of the analog output. The command format is:

ANALOG OPT [TOP or BOT] [LG or LN] [a b c d]

OPT indicates that the optional second analog output is being configured.

[TOP or BOT] specifies the top or bottom line of the display.

[LG or LN] specifies logarithmic (dBm) or linear (Watts) measurement.

The command string ends with four numeric variables (with at least one separator character between each pair of them), which define the relationship between the input power range and the output voltage range:

a: the power level represented by the minimum output voltage,
b: the power level represented by the maximum output voltage,
c: the minimum output voltage,
d: the maximum output voltage.

Valid power range numbers are -100 to +100 [dBm] for LOG, or 0 to 1E15 [Watts] for LIN. Valid voltage range numbers are 0.00 to +10.00 [VDC] (or -10.00 to +10.00, depending on Option 06 configuration).

Examples:

```
OUTPUT 713;ANALOG OPT TOP LOG -80.0, 20.0, 0.0, 10.0
                                  ! Configure the second analog output top line display channel
                                  ! as follows:
                                  ! log units, -80 to +20 dBm input, 0 to 10 volt output
OUTPUT 713;ANALOG OPT BOT LIN 0.00, 1.00E-3, 0.0, 1.0
                                  ! Configure the second analog output bottom line display
                                  ! channel as follows:
                                  ! lin units, 0 to 1.00 mW, 0 to 1 volt output
```

3.5 Averaging

3.5.1 Auto Averaging

The 8540C is normally used in the auto averaging mode. The power meter chooses an averaging factor that is appropriate for the ambient noise level.

Activating the Auto Filter Mode

The command which activates auto averaging for a sensor is based on the FA function. The command format is:

[AE or BE] FA

[AE or BE] prefix specifies Sensor A or Sensor B.

FA activates the auto filter mode for the selected sensor.

Example:

```
OUTPUT 713;AE FA          ! activate auto averaging filtering for sensor A
```

Setting the Measurement Settling Target

In the auto averaging mode, the 8540C chooses the lowest averaging factor that will yield a stable measurement at the present resolution setting. Stability is defined in terms of peak to peak variation in the measurement; the variation target value is expressed as a percentage of average power. Default values for this Measurement Settling Target are:

Table 3-7. Measurement Setting Target Default Values

Resolution	Peak to Peak Variation
xx.	25% (~1 dB)
xx.x	4.7% (~.2 dB)
xx.xx	0.46% (~.02 dB)
xx.xxx	0.10% (~.004 dB)

Because the target value affects the speed of measurement, it is possible to increase measurement speed by increasing the target value (a small increase in the target value can result in a large increase in speed). If the auto averaging mode is selected using the front panel menus, or the AE FA or BE FA commands as described above, the default target values shown in the table are used. However, it is possible to add a numeric variable after FA in order to specify a different target value:

[AE or BE] FA [t] [EN % or PCT]

[t] represents the measurement settling target value in per cent, and has a valid range of 0.10 to 100.00.

Example:

```
OUTPUT 713;BE FA .8 %     ! activate auto averaging filtering for sensor B, with
                          ! a measurement settling target of .8%
```

Freezing the Present Averaging Number

The command which causes auto filtering to hold its present averaging number is based on the FH function. The command format is

[AE or BE] FH

[AE or BE] prefix specifies sensor A or Sensor B.

FH causes the 8540C to hold its present averaging number; auto averaging is deactivated.

Example:

```
OUTPUT 713;BE FH          ! hold present average number for sensor B
```

3.5.2 Manual Averaging

The averaging number can be specified directly by the user. The commands which serve this purpose are based on the FM function. The command format is:

[AE or BE] FM [v] EN

[AE or BE] prefix specifies Sensor A or Sensor B.

FM specifies manual averaging.

[v] has allowable values of 0 through 9. Each value represents a particular averaging number. The numbers are shown in Table 3-8.

A terminating suffix is required (EN).

Table 3-8. Numbering Averaging

Value of *v*	Averaging Number	Value of *v*	Averaging Number
0	1	5	32
1	2	6	64
2	4	7	128
3	8	8	256
4	16	9	512

Examples:

```
OUTPUT 713;AE FM 2 EN     ! set averaging number to 4
OUTPUT 713;AE FM 8 EN     ! set averaging number to 256
```

3.6 Cal Factors

You should not need to employ the command described below with the 8540C; it is included here for the sake of compatibility with remote programs written for older power meters.

When a sensor is attached to the 8540C, the power meter automatically loads calibration factors from an EEPROM in the sensor. This data is frequency related, and in order for the 8540C to make use of it, the user must supply frequency information to the power meter, either by means of the front panel FREQ key, by means of the GPIB FR command (see FREQUENCY, Section 3.13), or by means of the VpropF input. Once the frequency has been specified, the 8540C automatically applies the appropriate cal factor to each reading.

The KB function code specifies a cal factor which is to be used in place of the cal factors stored in the sensor EEPROM. The command format is:

[AE or BE] KB [n] EN

[AE or BE] prefix specifies Sensor A or Sensor B.

[n] specifies a cal factor, expressed as a percentage with a valid range of 1.0 to 150.0.

A terminating suffix is required (EN).

Examples:

```
OUTPUT 713;AE KB 96 EN      ! enter a 96% cal factor for sensor A
OUTPUT 713;BE KB 102 EN     ! enter 102% cal factor for sensor B
```

3.7 Calibration

Commands which cause the 8540C to calibrate a sensor are based on the CL function code. The command format is:

[AE or BE] CL [n] [EN or PCT or %]

[AE or BE] prefix specifies Sensor A or Sensor B.

[n] represents a reference calibration factor of n%. The 8540C makes no use of this variable; instead it reads cal factors from the sensor EEPROM. The variable is included in the command format only for compatibility with power meters which require it. Any value between 50 and 120 can be entered for n.

A terminating suffix is required (EN, PCT, or %).

Examples :

```
OUTPUT 713;AE CL 100 EN        ! Calibrate sensor A
OUTPUT 713;BE CL 100 EN        ! Calibrate sensor B
```

The appropriate sensor must be attached to the calibrator output in order for the calibration process to work. If the sensor is not attached, the calibration will fail, and operation will continue as before.

Calibration Routine

The following is an example of a GPIB program to calibrate a sensor. It is strongly recommended that this format be followed for remote calibration. Note that the service request feature is used to determine when the calibration has completed; this will result in the quickest calibration routine.

Example:

```
Calibrate:                     ! calibration routine
ON INTR 7 GOSUB Srq_interrupt  ! setup serial poll interrupt
                               ! jump location
ENABLE INTR 7;2                ! enable SRQ interrupts
OUTPUT 713;*SRE010             ! set service request mask to 2
OUTPUT 713;CS                  ! clear status byte
OUTPUT 713;CL100EN             ! start calibration
Flag=0                         ! reset control flag
WHILE Flag=0                   ! wait while calibrating
END WHILE
RETURN
Srq_interrupt:                 ! SRQ interrupts jump here
OUTPUT 713;*STB?
ENTER 713;State
IF BIT(State, 1) THEN
   PRINT GOOD CAL
   ELSE
        IF BIT(State, 3) THEN
            PRINT BAD CAL
            ENDIF
ENDIF
OUTPUT 713;CS                  ! clear status byte
Flag=1                         ! set control flag true
RETURN
```

3.8 Calibrator Source

The 8540C Calibrator output (a fixed 50 MHz signal at 0 dBm) is activated and deactivated by means of two simple commands:

[OC1 or OC0]

Examples:

```
OUTPUT 713;OC1          ! turn on calibrator source
OUTPUT 713;OC0          ! turn off calibrator source
```

The output level of the 50 MHz signal is subject to drift over time, and is considered accurate only within ten minutes after it has been activated.

☛ **NOTE:** This command is needed for test purposes only. The calibrator source is enabled automatically during calibration of a sensor.

3.9 Crest Factor

The Crest Factor feature holds on to the highest instantaneous power measured from the time the feature is enabled until it is reset; it is similar to the Peak Hold feature, except that the measurement is expressed as a ratio in relation to average power.

☛ **NOTE:** The Crest Factor feature can only be used in the standard measurement collections modes (not in the fast modes), and only in a modulated measurement mode (MAP, PAP, or BAP). Crest Factor is not recommended for use in combination with the VpropF function.

3.9.1 Enabling the Crest Factor Feature

The Crest Factor feature is enabled or disabled by simple commands consisting of one of two function codes:

[CR0 or CR1]

Examples:

```
OUTPUT 713;CR1          ! Enable the Crest Factor feature
OUTPUT 713;CR0          ! Disable the Crest Factor feature
```

☛ **NOTE:** Like the PH0 and MN0 commands, this command will disable Peak Hold and Min/Max measurements.

3.9.2 Reading the Crest Factor Value

The Crest Factor value is read over the bus using a simple command:

CRF

Example:

```
OUTPUT 713;CRF          ! Send the crest factor value
```

The Crest Factor feature monitors the maximum power as it is measured, but does not provide any feedback to the controller until a CRF command is received. To monitor for a limit violation, the Limits feature may be more useful (see Section 3.16).

The Crest Factor feature returns the current ratio between held power and average power, as displayed on the front panel. A CRF command does not initiate data collection in same manner as a trigger command, such as TR1. To get a good reading of the Peak Hold value, the procedure is:

1. Set up the signal being measured, and send CR1 to reset the Crest Factor measurement.
2. Send TR2.
3. Read the TR2 data, or wait for the data ready service request (this allows for settling).
4. Send CRF.
5. Read the Crest Factor value.

3.10 Display Control

Testing the Displays

The LCD display window and status LEDs on the 8540C front panel can be tested remotely, by means of three simple commands:

[DA or DD or DE]

Examples:

```
OUTPUT 713;DA      ! turn on all LCD display segments and status LEDs
OUTPUT 713;DD      ! turn off all LCD display segments and status LEDs
OUTPUT 713;DE      ! activate the LCD display and the status LEDs
                   ! (this has the effect of canceling a DA or DD command)
```

Displaying a Message

The DU function can show a test message in the LCD display window. The command format for this purpose is:

DU [string]

The test message string can contain up to 32 characters; the first sixteen characters will be shown on the top line of the LCD display window, and the remaining characters will be shown on the bottom line.

Example:

```
OUTPUT 713;DU THIS IS A TEST   ! show the message THIS IS A TEST on the
                               ! LCD display window
```

3.11 Duty Cycle Commands

3.11.1 Activating or Deactivating a Duty Cycle

The commands which activate or deactivate a duty cycle are based on the DC0 and DC1 functions. The command format is:

[AE or BE] [DC0 or DC1]

[AE or BE] prefix specifies Sensor A or Sensor B.

[DC0] turns the duty cycle off (for the specified sensor); if the sensor is in Pulse Average Power measurement mode, this command will change the sensor measurement mode to Modulated Average Power. If the sensor is not measuring Pulse Average Power at the time this command is received, then this command will have no effect.

[DC1] turns the duty cycle on. This is equivalent to the PAP command (see Measurement Mode Commands in Section 3.19).

Examples:

```
OUTPUT 713;AE DC0          ! turn off the duty cycle for sensor A
OUTPUT 713;BE DC1          ! turn on the duty cycle for sensor B
```

3.11.2 Specifying a Duty Cycle

The commands which specify a duty cycle are based on the DY function. The command format is:

[AE or BE] DY [n] [EN or PCT or %]

[AE or BE] prefix specifies Sensor A or Sensor B.

DY specifies a duty cycle value; it also configures the sensor to Pulse Average Power mode. Therefore, this function includes the capabilities (and entry error reporting) of the PAP function (see Measurement Mode Commands in Section 3.19).

[n] species the duty cycle value in percent with a valid range of .001 to 99.999).

A terminating suffix is required (EN, PCT, or %).

Examples:

```
OUTPUT 713;AE DY 50 %          ! set 50% duty cycle for sensor A
OUTPUT 713;BE DY 25.000 EN     ! set 25% duty cycle for sensor B
OUTPUT 713;BE DY 40.412 PCT    ! set 40.412% duty cycle for sensor B
```

3.11.3 Reading Duty Cycle Status

The status message byte O indicates whether the duty cycle function is active for the selected sensor. 0 indicates OFF; 1 indicates ON.

3.12 EEPROM

The EEPROM command is used to query the cal factor data in the sensor EEPROM. The cal factor data is typically stored in the EEPROM at 1 GHz steps over the frequency range of the sensor. Additional cal factors may also be stored at additional special frequencies. When a measurement frequency is specified which does not exactly match the frequencies at which cal factors have been stored, the power meter determines the appropriate cal factor via interpolation.

Commands to read EEPROM cal factor data are based on the EEPROM function code. The command format is:

EEPROM [A or B] [CALF? or FREQ?]

[A or B] specifies Sensor A or Sensor B.

[CALF?] queries the cal factors. The cal factor data is output as a table of cal factors expressed in dB, separated by commas.

[FREQ?] queries the frequencies which correspond to the cal factors. The frequency data is output as a table of frequencies expressed in Hz, separated by commas.

Examples:

```
OUTPUT 713;EEPROM A CALF?
```

Response is:

```
0.00, 0.00, 0.00, 0.00, 0.00, 0.00, 0.00, 0.00, 0.00, 0.00, 0.00, 0.00, 0.00, 0.00, 0.00, 0.00, 0.00, 0.00
                                        ! Query sensor A EEPROM whole cal factor table
                                        ! (This example is from an 80301A sensor)
OUTPUT 713;EEPROM A FREQ?
```

Response is:

```
5.000e7, 2.000e9, 3.000e9, 4.000e9, 5.000e9, 6.000e9, 7.000e9, 8.000e9, 9.000e9, 1.000e10,
1.100e10, 1.200e10, 1.300e10, 1.400e10, 1.500e10, 1.600e10, 1.700e10, 1.800e10
                                        ! Query sensor A EEPROM whole frequency table
                                        ! (This example is from an 80301A sensor)
```

3.13 Frequency

Cal factors are stored in the sensor's EEPROM by frequency. Specifying a frequency causes the 8540C to apply the cal factor appropriate to that frequency. To cancel the use of cal factors, specify a frequency of 50 MHz (this is the frequency of the front panel Calibrator reference output, and has a cal factor of zero).

Commands which specify a frequency are based on the FR function. The command format is:

[AE or BE] FR [n] [HZ or KZ or MZ or GZ]

[AE or BE] prefix specifies Sensor A or Sensor B.

FR specifies a frequency value.

[n] specifies the frequency value (the units are Hz, kHz, MHz, or GHz, depending on the terminating suffix used).

A terminating suffix is required (HZ, KZ, MZ, or GZ).

Examples:

```
OUTPUT 713;AE FR 5.67 GZ        ! frequency for sensor A is 5.7 GHz
OUTPUT 713;AE FR 1.0E9 HZ       ! frequency for sensor A is 1E9 Hz (1 GHz)
OUTPUT 713;BE FR 84.6 MZ        ! frequency for sensor B is 84.6 MHz
OUTPUT 713;BE FR 4E6 KZ         ! frequency for sensor B is 4E6 kHz (4 GHz)
```

3.14 Instrument Identification

The 8540C can be queried over the GPIB for purposes of identification; user application programs make use of such queries in order to verify that the appropriate equipment is connected. The 8540C will reply to an ID query by sending back an identification string.

The simple commands which query the instrument ID consist of any of three function codes:

[ID or ?ID or *IDN?]

Example:

```
OUTPUT 713;*IDN?          ! ask for ID string
ENTER 713; Name           ! read ID into string variable Name
```

Identification Strings

The ID string is determined by the configuration choices that were made (from the front panel) under the Config/GPIB menu. In the 8541 or 8542 mode, the ID string consists of four fields separated by commas:

Field 1 is the manufacturer (GIGA-TRONICS).
Field 2 is the model (8541C or 8542C).
Field 3 is the serial number field (it displays the serial number of the calibrator EEPROM)
Field 4 is the software version number.

Example strings:

```
8541 mode     Name = GIGA-TRONICS,8541C,9544112,3.00
8542 mode     Name = GIGA-TRONICS,8542C,9548024,3.00
```

However, the ID strings for the emulation modes are fixed, as follows:

```
437 mode      Name = HEWLETT-PACKARD,437B,1.8
438 mode      Name = HP438A,VER1.10
436 mode      Not Applicable
```

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3.15 Learn Modes

The 8540C has the ability to send information regarding its current configuration to the controller. The controller requests this information by sending a learn mode command. At a later time, the controller can send the configuration information back to the power meter in order to reconfigure the 8540C to the same state it was in when it received the learn mode command.

Conceptually this feature is similar to the store and recall capability of the 8540C but with several important differences:

- The configuration information is stored in the controller's memory and not in the 8540C memory.
- Learn Mode #1 returns information regarding the current GPIB operational configuration (such as the trigger mode) which would not be covered by the store/recall function.
- The learn modes do not support many of the advanced features of the 8540C.
- The learn modes involve transmission of long strings of data between the controller and the 8540C. These strings must be transmitted without interruption; transmissions cannot be considered complete until EOI is read.

The two learn modes are discussed under separate headings on the following pages.

The learn modes are provided for the sake of compatibility with remote programs written for older power meters. The configuration information returned to the host is not as complete as the information that would be stored in the 8540C memory using the store/recall function; the configuration data for many features of the 8540C are not included in the learn mode data.

3.15.1 Learn Mode #1

Learn Mode #1 is used to return the configuration of the 8540C to the controller in the form of a sequence of GPIB commands.

Requesting the String

The simple command which requests the Learn Mode #1 string has the following format:

```
LP1
```

Example:

```
OUTPUT 713;LP1                    ! requests learn mode #1 string
```

After receiving the LP1 command, the 8540C will return the Learn Mode #1 string the next time it is addressed to talk. The string will consist of up to 128 ASCII characters. The last character is sent with EOI true. Table 3-9 shows the information contained in the Learn Mode #1 string, and the order in which it is sent.

Table 3-9. Learn Mode #1 Output Format

Parameter	Output from the Power Meter[1]
Trigger Mode	TRd
Measurement Mode	AP, BP, AR, BR, AD, or BD
SENSOR A PARAMETERS	AE
Cal Factor	KB ddd.d EN
Offset	OS ±dd.dd EN
Range	RA d EN
Filter	FA or FM d EN
Low Limit	LL ±ddd.ddd EN
High Limit	LH ±ddd.ddd EN
SENSOR B PARAMETERS	BE
Cal Factor	KB ddd.d EN
Offset	OS ±dd.dd EN
Range	RA d EN
Filter	FA or FM d EN
Low Limit	LL ±ddd.ddd EN
High Limit	LH ±ddd.ddd EN
Active Entry Channel	AE or BE
Measurement Units	LG or LN
Reference Oscillator Status	OC0 or OC1
Group Trigger Mode	GTd
Limits Checking Status	LM0 or LM1
Carriage Return Line Feed	EOI

[1] ± indicates sign; d indicates a single digit.

Sending the String

The power meter can be restored to the configuration described in the Learn Mode #1 string, by sending the string to the 8540C.

3.15.2 Learn Mode #2

Learn Mode #2 is used to return the 8540C configuration information to the controller in the form of a series of binary values.

Requesting the String

The simple command which requests the Learn Mode #2 string has the following format:

```
LP2
```

Example:

```
OUTPUT 713;LP2                    ! requests learn mode #2 string
```

After receiving the LP2 command, the 8540C will return the Learn Mode #2 string the next time it is addressed to talk. The string starts with two ASCII characters, @ and 2, followed by a string of 28 (58 for the 437 emulation mode) 8-bit binary bytes. The last byte is sent with EOI true. Learn Mode #2 requires a controller that can receive and send information in binary form.

The Learn Mode #2 string contains the following information:

- Measurement mode
- REL mode status (on or off)
- Reference oscillator status (on or off)
- Current reference value if in REL mode
- Measurement units (Log or Lin)
- Cal Factor for each sensor
- Offset for each sensor
- Range for each sensor
- Filter for each sensor

Sending the String

The command that sends the Learn Mode #2 data to the 8540C is based on the @2 function. The command format is:

binary bytes

The 8540C will change its configuration to match the configuration defined by the Learn Mode #2 string.

3.16 Limits

3.16.1 Setting Limits

Commands which set limits are based on the LH and LL function codes. The command format is:

[AE or BE] [LH or LL] [n] EN

For limit commands, the [AE or BE] prefix specifies a line of the display rather than a sensor.

[AE] specifies the top line of the display.

[BE] specifies the bottom line.

[LH] specifies the high limit; LL specifies the low limit.

[n] is a limit value, expressed in dBm or dB as appropriate.

A terminating suffix is required (EN).

Examples:

```
OUTPUT 713;AE LH 12.34 EN      ! set top line high limit to +12.34 dB
OUTPUT 713;AE LL -2.58 EN      ! set top line low limit to -2.58 dB
OUTPUT 713;BE LH 2.34 EN       ! set bottom line high limit to +2.34 dB
OUTPUT 713;BE LL -100.00 EN    ! set bottom line low limit to -100.00 dB
```

3.16.2 Activating Limits

Limit-checking is activated or deactivated by simple commands consisting of one of two function codes:

[AE or BE] [LM0 or LM1]

For limit commands, the [AE or BE] prefix specifies a line of the display rather than a sensor.

[AE] specifies the top line of the display.

[BE] specifies the bottom line.

[LM0] disables limit checking.

[LM1] enables limit checking.

Examples:

```
OUTPUT 713;AE LM0      ! disable limit checking for the top line
OUTPUT 713;BE LM1      ! enable limit checking for the bottom line
```

Before enabling limit checking (LM1), you must set the high and low limits (LH and LL). Once enabled, the Status Byte (bit 4) will signal a too high or too low condition. The status message AA bytes will indicate a too high condition (error code 21), or a too low condition (error code 23). Status Message bytes L and M contain the limit status for the top line display and the bottom line display respectively. 0 indicates within limits, 1 indicates too high, and 2 indicates too low.

The LCD display will indicate a too high condition with an up arrow displayed to the left of the reading, and a down arrow displayed to the left of the reading for a too low condition. If the sound mode is enabled, a high or low pitched sound will be generated. Sound can be disabled using the Config menu.

3.16.3 Measuring with Limits

For Sensor A or B, measurements with limits is enabled by the command

LM1.

Examples:

```
OUTPUT 713; AP LM1          ! Measure sensor A and enable limit checking
```

This measures Sensor A with the previously set AE, LL and LH limits.

```
OUTPUT 713; BP LM1          ! Measure sensor B and enable limit checking
```

This measures Sensor B with previously set BE, LL and LH limits.

To measure Sensor A and B simultaneously (Model 8542 only) with limits enabled (LM1),

1. Press [ENTER].
2. Press [MENU].
3. Enter the menu format (**A, B, A/B ..., OFF**).
4. Select **Top Line** and press the left/right cursor keys until A appears.
5. Select **Bottom Line** and press the left/right cursor keys until B appears.
6. Press [ENTER].

Example:

```
OUTPUT 713; AE LM1          ! Enable limit checking for the top line
OUTPUT 713; BE LM1          ! Enable limit checking for the bottom line
```

This allows the power meter to display both sensor readings and enables both of the previously set AE and BE, LL and LH limits for Sensors A and B.

3.17 Measurement Collection Modes (Standard)

3.17.1 Measurement Triggering

Trigger modes determine when a measurement will be made. Four simple commands (consisting of one of four function codes) are used to select the desired mode:

[TR0 or TR1 or TR2 or TR3]

All four modes discussed here are standard measurement collection modes (as opposed to the fast modes described in Section 3.17), and use the standard data output format.

Trigger Hold (TR0)

This command places the instrument in standby mode. The LCD display is frozen at the current values. The display will be updated when the instrument receives a TR1 or TR2 command. To resume the normal free run mode of the instrument and display, use the TR3 command. During the standby mode, the instrument continues to make measurements and update the internal digital filter, but does not update the display or the GPIB buffer.

Example:

```
OUTPUT 713;TR0          ! Select the trigger hold mode
```

Trigger Immediate (TR1)

This command triggers a single reading; the reading is added to the internal digital filter. An ENTER statement will return the updated filter power level. After a TR1 command, the instrument returns to the standby mode.

Example:

```
OUTPUT 713;TR1          ! Trigger a single measurement
```

Trigger Immediate with Full Averaging (TR2)

This mode triggers a new series of readings; enough to update the digital filter for a noise free reading at the current power level. An ENTER statement will return the fully updated filter power level. After a TR2 command, the instrument returns to the standby mode.

Example:

```
OUTPUT 713;TR2          ! Trigger a full measurement, with settling
```

Free Run (TR3)

This free run trigger mode (which is the default mode) allows the user to read the power at any time with an ENTER statement. There is no need to send the TR3 command again. Multiple ENTER statements can be executed. The power meter will return the present power level just as if you had looked at the LCD display.

Example:

```
OUTPUT 713;TR3          ! Free run trigger mode
```

3.17.2 Group Execute Trigger

The GPIB GET command (group execute trigger) causes all the devices on the interface which are currently addressed to listen to start a device dependent operation (usually a measurement). Three simple commands (consisting of one of three function codes) regulate the 8540C response to a GET command:

[GT0 or GT1 or GT2]

Group Trigger Cancel (GT0)

This command disables the response of the 8540C to a GPIB GET command.

Example:

```
OUTPUT 713;GT0          ! Group execute trigger cancel
```

Group Trigger Immediate (GT1)

This mode is similar to the mode specified by the TR1 command (trigger immediate), except that the GT1 command causes the 8540C to wait for a GPIB GET command. When the GET command is received, it triggers a single reading which is added to the internal digital filter. An ENTER statement will return the updated filter power level. After a GT1 command, the instrument is placed in the standby mode.

Example:

```
OUTPUT 713;GT1          ! Group execute trigger single measurement
```

Group Trigger Immediate with Full Averaging (GT2)

This mode is similar to the mode specified by the TR2 command (trigger immediate with full averaging), except that the GT2 command causes the 8540C to wait for a GPIB GET command. When the GET command is received, it triggers a new series of readings; enough to update the digital filter for a noise free reading at the current power level. An ENTER statement will return the fully updated filter power level. After a GT2 command, the instrument is placed in the standby mode.

Example:

```
OUTPUT 713;GT2          ! Group execute trigger full measurement with settling
```

3.18 Measurement Collection Modes (Fast)

3.18.1 General

The 8540C offers three special fast measurement collection modes which are available only during remote operation over the GPIB. These fast modes make it possible to take more measurements per second, but at the cost of limited functionality compared to the standard measurement collection mode. The fast modes operate differently from the standard measurement collection mode in several important ways. The three fast modes are called Swift, Fast Buffered, and Fast Modulated.

Sensor Measurements Supported

One restriction on the 8540C functionality in the fast modes is that it cannot perform comparative measurements (that is, measurements consisting of a comparison between the two sensors, such as A/B or A-B). However, when the 8540C operates in the Swift and Fast Buffered modes, it does have an added capability which is not otherwise available: measurements from both sensors can be returned to the host. In the Fast Modulated mode, only one sensor measurement can be performed and returned to the host.

Averaging

The averaging feature has a unique implementation in the Swift and Fast Buffered modes. Note that in standard measurement collection modes, and in the Fast Modulated modes, the averaging factor is taken to indicate the amount of filtering desired. Each measurement which is returned to the host is a true running average for a period of time which is derived from the averaging factor.

In the Swift and Fast Buffered modes, the averaging indicates the exact number of samples to be taken for each returned measurement, with the proviso that a minimum of four samples are taken (even if a number below four is requested). Note that four samples are also taken if auto averaging is selected. Each measurement returned to the host reflects all new data. Therefore, operation will be much faster with an averaging number of four than with a higher number.

Disabled Features

The following features are disabled during operation in any of the three fast modes: over-range alert, limit checking, min/max power, relative measurements, peaking meter, analog output, and Vprop[F] (voltage proportional to frequency) correction.

Measurement Changes

Other changes to the operation of the instrument during fast operation include the following: the temperature of the sensors is not read and updated, so the temperature correction will become inaccurate over time if the temperature of the sensor changes.

Warning Regarding Interruption and Reconfiguration

Another important consideration is that, while any of the three fast measurement modes is running, it should not be interrupted, and the measurement setup should not be changed. The measurement setup must be thoroughly configured before the command is sent to start the fast measurement mode. To reconfigure the instrument, or to zero a sensor, it is necessary to exit the fast mode and then restart it. If a measurement setup command is sent after a fast mode command, the results are undefined.

Fast Mode Setup

Prior to initiating a fast measurement collection mode, the host should select the measurement (i.e., AP or BP), select the measurement mode (i.e., CW, MAP, PAP, PEAK, or BAP), define the frequency correction (via the FR or KB command, but not via the VpropF function), define the offset (if any), define the averaging (via the FA or FM command), and define the duty cycle (if applicable).

When a fast mode is initiated, the LCD display and the status LEDs will be blanked and a message will be displayed indicating the fast mode selected.

3.18.2 Data Output Formats for Fast Modes

The data output formats for fast measurement collection are illustrated below. Fast mode data is always returned in units of dBm. Each A or B represents a single digit (0 to 9).

For the Swift Free-Run Mode

If one sensor is used, the format is:

±AAA.AA CR LF
±AAA.AA CR LF etc.
or:
±BBB.BB CR LF
±BBB.BB CR LF etc.

If two sensors are used, the format is:

±AAA.AA, ±BBB.BB CR LF
±AAA.AA, ±BBB.BB CR LF etc.

For The Swift Triggered & Fast Buffered Modes

If one sensor is used, the format is :

±AAA.AA, ±AAA.AA, etc. CR LF
or:
±BBB.BB, ±BBB.BB, etc. CR LF

If two sensors are used, the format is:

±AAA.AA, ±AAA.AA, etc. [until the specified number of readings has been sent]
±BBB.BB, ±BBB.BB, etc. [until the specified number of readings has been sent],
CR LF

For the Fast Modulated Mode

In this mode, only one sensor can be used; the format is:

±AAA.AA CR LF
±AAA.AA CR LF etc.
or:
±BBB.BB CR LF
±BBB.BB CR LF, etc.

☛ **NOTE:** If BAP is unable to sync, 200.00 is added to the actual value in order to flag this error condition.

3.18.3 Fast Buffered Mode

Fast Buffered Mode is a fast measurement collection mode which makes it possible for a series of measurements to be taken and buffered rapidly, without external triggering of each measurement. The measurement collection can consist of a buffer-load of measurements taken after a trigger, or a buffer-load of measurements taken prior to a trigger (that is, the trigger marks the beginning or the end of the measurement period, depending on the option selected). This mode also makes it possible to buffer a very large number of data points, if optional RAM is installed for the purpose. For the sake of speed, no chopped measurements are taken in the fast buffered mode.

The fast buffered mode cannot be entered if a modulated measurement (MAP, PAP, or BAP) is being performed.

Commands related to the fast buffered mode are based on the FBUF command. (For the sake of backward compatibility with earlier Giga-tronics power meter designs, the command BURST is accepted as a substitute for FBUF. However, this command has nothing to do with the burst average power measurement mode; it is a vestige of the terminology applicable to previous models.) For the FBUF commands, the command format is:

FBUF [PRE or POST] [GET or TTL] BUFFER [b] TIME [t]

[PRE or POST] define the relationship between the measurement period and the trigger:

[PRE] the trigger marks the end of the measurement period. The 8540C will continuously take measurements and buffer them until a trigger is received. At that point, it will stop collecting data and output all of the previously collected data in a continuous data stream the next time it is addressed to talk.

[POST] the trigger marks the beginning of the measurement period. The 8540C will wait for a trigger before taking and buffering the measurements. After the requested number of measurement have been taken and buffered, it will be ready to output all of the data in a continuous stream the next time it is addressed to talk. If the GPIB GET command is specified as the trigger, the 8540C will assert a service request at this time.

[GET or TTL] define the trigger:

[GET] the expected trigger is a GPIB GET command.

[TTL] the expected trigger is a TTL high at the rear panel trigger input.

The buffer value (numeric variable [b]) specifies the number of measurements to be taken and stored in the buffer. The minimum value is one. The maximum value is normally 5,000. However, if optional extra RAM is installed, the maximum value is 64,000 (when two sensors are used), or 128,000 (if one sensor is used).

The time value (numeric variable [t]) is an optional variable which specifies a fixed delay between measurements. The time value specifies the time (in ms) to wait between measurements; the minimum value is zero. The maximum value is 5000 ms (five seconds). Note that this delay is in addition to the relatively short time it takes to perform each measurement. If no time value is specified, [t] is assumed to be zero, and the measurements are taken as fast as possible.

Examples:

```
OUTPUT 713;FBUF PRE GET BUFFER 200
                                    ! take measurements (as fast as possible) until GET is received
                                    ! then output the last 200 measurements taken
```

```
OUTPUT 713;FBUF POST TTL BUFFER 100 TIME 2
                                    ! wait for a TTL trigger, then take readings at intervals of 2 ms
                                    ! until a total of 100 measurements have been taken
```

Two simpler commands are also based on the FBUF function code:

FBUF [DUMP or OFF]

[DUMP] stops the data measurement and buffering, and prepares to return the data taken so far to the host, even if fewer than the requested number of measurements have been taken. The requested number of measurements are still returned to the host (the extra measurements beyond those actually taken are represented by the number -300.00).

[OFF] causes the 8540C to exit the fast buffered mode. All unread data is lost.

Examples:

```
OUTPUT 713;FBUF DUMP        ! Stop measurement and buffering
OUTPUT 713;FBUF OFF         ! Exit the fast buffered mode
```

Notes on Speed in the Fast Buffered Mode

The fast buffered mode is the fastest method of collecting measurement data. Top speed in the fast buffered mode is achieved by using a low averaging number (≤4), the POST trigger mode, and no time delay between measurements.

The POST trigger mode is faster than the PRE trigger mode because in the latter mode the 8540C must check for a trigger between each measurement. In the POST mode, the 8540C is in freerun operation after the trigger is received.

3.18.4 Swift Mode

Swift mode is a fast mode which allows for fast continuous data taking and return of each measurement to the host as it is taken (the freerun mode). Swift mode also allows for triggered buffered measurements, in which a host or external trigger indicates when to take each measurement.

The swift mode cannot be entered if a modulated measurement (MAP, PAP, or BAP) is being performed.

Commands related to the swift mode are based on the SWIFT function code:

SWIFT [FREERUN or OFF]

[FREERUN] initiates the freerun mode (continuous taking and returning of measurements).

[OFF] causes the 8540C to exit the swift mode; all unread data is lost.

Examples:

```
OUTPUT 713;SWIFT FREERUN      ! Initiate swift freerun mode
OUTPUT 713;SWIFT OFF          ! Exit the swift mode
```

For commands which set up triggered measurements, the command format is:

SWIFT [GET or TTL] BUFFER [b]

[GET or TTL] define the trigger:

[GET] the expected trigger is a GPIB GET command. The 8540C signals the host by asserting SRQ every time it is ready to take a measurement.

[TTL] the expected trigger is a TTL high at the rear panel trigger input. The 8540C signals the host by setting the RF Blanking BNC output high every time it is ready to take a measurement.

For triggered measurements, the 8540C signals the host every time it is ready to take a measurement (consisting of a set of samples equal to the averaging number). The 8540C then waits for the trigger; when the trigger is received, the 8540C de-asserts the signal to the host, measures the data, and buffers the data. When the instrument is again ready to measure data, it again asserts the signal to the host. After the specified number of measurements, the 8540C is ready to output data.

BUFFER (followed by the numeric variable [b]) specifies the number of measurements to be taken and stored in the buffer. The minimum value is one. The maximum value is 5000.

Examples:

```
OUTPUT 713;SWIFT PRE GET BUFFER 200      ! take measurements until GET is received
                                         ! then output the last 200 measurements
                                         taken

OUTPUT 713;SWIFT POST TTL BUFFER 100     ! wait for a TTL trigger, then take 100
                                         measurements
```

Example Programs

The following program can measure, buffer, and print 30 readings on one sensor:

```
REAL Data(30)
OUTPUT 713;SWIFT GET BUFFER 30
WAIT 0.5                          ! wait for instrument configuration
FOR I=1 to 30
   Srq_flag=0                     ! wait for ready condition
   TRIGGER 713                    ! trigger measurement
WHILE Srq_flag=0
   Srq_flag=SPOLL(713)
   END WHILE
NEXT I
   ENTER 713;Data(*)
   FOR I=1 TO 30
   PRINT I,Data(I)
NEXT I
```

☛ **NOTE:** If your computer does not support matrix reads, you can read the entire buffer into a string and parse the data. Multiple ENTER commands will not work.

The following program can be used to perform 20 measurements on two sensors in swift freerun mode:

```
OUTPUT 713;APBP
OUTPUT 713;SWIFT FREERUN
WAIT 0.5
FOR I=1 to 20
   ENTER 713;ReadA,ReadB
   PRINT ReadA,ReadB
NEXT I
OUTPUT 713;SWIFT OFF
```

The following program can be used to measure, buffer, and print 30 readings on each of two sensors:

```
REAL DataA(30),DataB(30)
OUTPUT 713;SWIFT GET BUFFER 30
WAIT 0.5
FOR I=1 to 30
   srq_flag=0
   TRIGGER 713                    ! send group execute trigger
WHILE srq_flag=0
   srq_flag=SPOLL (713)
   END WHILE
NEXT I
ENTER 713;DataA(*),DataB(*)       ! read the buffer
FOR I=1 to 30
   PRINT I,DataA(I),DataB(I)
NEXT I
```

3.18.5 Fast Modulated Mode

This is a fast mode which permits more frequent return of measurement data to the host, during operation in the modulated measurement modes (MAP, PAP, or BAP). The commands which activate or deactivate this mode are based on the FMOD function code:

FMOD [ON or OFF]

[ON or OFF] enables or disables the fast modulated mode.

When the fast modulated mode is enabled, data will be taken and returned continuously. This is analogous to the swift freerun mode.

The fast modulated mode cannot be initiated unless a modulated measurement (MAP, PAP, or BAP) is being performed.

Examples:

```
OUTPUT 713;FMOD ON          ! Enable fast modulated mode
OUTPUT 713;FMOD OFF         ! Disable fast modulated mode
```

3.19 Measurement Mode Commands

3.19.1 CW Mode

Commands which specify the CW measurement mode are based on the CW function code:

CW [A or B]

[A or B] specifies Sensor A or Sensor B.

These commands can be used with any sensor (although it is superfluous in the case of a CW sensor). Possible GPIB entry errors: 60 (uncalibrated sensor), 61 (missing sensor).

Examples:

```
OUTPUT 713;CW A          ! select CW mode for sensor A
OUTPUT 713;CW B          ! select CW mode for sensor B
```

3.19.2 MAP Mode

Commands which specify the modulated average power measurement mode are based on the MAP function code:

MAP [A or B]

[A or B] specifies Sensor A or Sensor B.

These commands will work only with a modulated sensor. Possible GPIB entry errors: 60/61 (uncalibrated or missing sensor A/B), 62/63 (not a modulated sensor, or two sensor operation active, A/B).

Examples:

```
OUTPUT 713;MAP A         ! select MAP mode for sensor A
OUTPUT 713;MAP B         ! select MAP mode for sensor B
```

If an irregularly modulated signal is measured in MAP mode, measurement settling time will vary as the power meter attempts to synchronize to the modulation. In such a situation, it may be desirable to disable synchronization for faster measurement. The commands which disable synchronization are based on the MAP function code.

MAP [A or B] 0

[A or B] specifies Sensor A or Sensor B.

0 specifies that synchronization is to be disabled.

Examples:

```
OUTPUT 713;MAP A 0       ! disable MAP mode synchronization for sensor A
OUTPUT 713;MAP B 0       ! disable MAP mode synchronization for sensor B
```

☛ **NOTE:** To reactivate synchronization, send the MAP A or MAP B command again.

3.19.3 PAP Mode

Commands which specify the pulse average power measurement mode are based on the PAP function code:

PAP [A or B]

[A or B] specifies Sensor A or Sensor B.

These commands will work only with a modulated sensor. Possible GPIB entry errors: 60/61 (uncalibrated or missing sensor A/B), 62/63 (not a modulated sensor, or two sensor operation active, A/B).

Examples:

```
OUTPUT 713;PAP A          ! select PAP mode for sensor A
OUTPUT 713;PAP B          ! select PAP mode for sensor B
```

3.19.4 BAP Mode

Commands which specify the burst average power measurement mode are based on the BAP function code:

BAP [A or B]

[A or B] specifies Sensor A or Sensor B.

These commands will work only with a modulated sensor. Possible GPIB entry errors: 60/61 (uncalibrated or missing sensor A/B), 62/63 (not a modulated sensor, or two sensor operation active, A/B).

Examples:

```
OUTPUT 713;BAP A          ! select BAP mode for sensor A
OUTPUT 713;BAP B          ! select BAP mode for sensor B
```

3.19.5 PEAK Mode

The commands for Peak mode are discussed under separate headings for the 80350A and 80340A sensors (see Sections 3.24 and 3.25, respectively).

3.19.6 Measurement Mode Query

It is possible to query the 8540C over the bus to determine what measurement mode has been selected for a particular sensor. The 8540C will respond to a measurement mode query by returning one of the following strings to the controller:

NO SENSOR
UNCAL
CW
MAP (or MAP SYNC OFF)[1]
PAP
PEAK
BAP (or BAP *a b c*)[2]

Measurement mode query commands are based on the MEAS function code:

Notes:

1. MAP SYNC OFF will be returned if MAP mode synchronization has been disabled.
2. BAP *a b c* will be returned if any of the advanced features have been enabled. In this message, a represents the number of samples for burst start exclude, b represents the number of samples for burst end exclude, and c represents burst dropout time in ms. The value ranges are $0 \leq a \leq 512$; $0 \leq b \leq 512$; $0.00 \leq c \leq 31.96$

MEAS [A? or B?]

[A? or B?] specifies Sensor A or Sensor B.

Examples:

```
OUTPUT 713;MEAS A?        ! queries the measurement mode setting for sensor A
OUTPUT 713;MEAS B?        ! queries the measurement mode setting for sensor B
```

3.20 Advanced Features

3.20.1 Burst Start Exclude

Commands which cause the beginning of a burst to be excluded from measurement (this feature is applicable only in BAP mode) are based on the BSTE function code:

[AE or BE] BSTE [a] EN

[AE or BE] prefix specifies Sensor A or Sensor B.

[a] specifies the number of samples to be excluded; it has an integer value in the range of 0 to 512. (selecting a value of zero samples effectively disables this function).

A terminating suffix is required (EN).

Examples:

```
OUTPUT 713;AE BSTE 1 EN      ! exclude one sample from start of burst, for BAP
                             ! measurements on sensor A
OUTPUT 713;BE BSTE 3 EN      ! exclude three samples from start of burst, for BAP
                             ! measurements on sensor B
```

3.20.2 Burst End Exclude

Commands which cause the end of a burst to be excluded from measurement (this feature is applicable only in BAP mode) are based on the BSPE function code:

[AE or BE] BSPE [a] EN

[AE or BE] prefix specifies Sensor A or Sensor B.

[a] specifies the number of samples to be excluded; it has an integer value in the range of 0 to 512. (Note: selecting a value of zero samples effectively disables this function).

A terminating suffix is required (EN).

Examples:

```
OUTPUT 713;AE BSPE 1 EN      ! exclude one sample from end of burst, for BAP
                             ! measurements on sensor A
OUTPUT 713;BE BSPE 3 EN      ! exclude three samples from end of burst, for BAP
                             ! measurements on sensor B
```

3.20.3 Burst Dropout Tolerance

Commands which define a tolerated burst dropout time (this feature is applicable only in BAP mode) are based on the BTDP function code:

[AE or BE] BTDP [a] EN

[AE or BE] prefix specifies Sensor A or Sensor B.

[a] specifies the dropout time in milliseconds with a range of 0 to 31.96, and a resolution of .01 ms. However, the value entered will be rounded upwards to one of a series of discrete values (.017, .026, .035 etc.); the actual value can be checked by means of a MEAS query. The dropout time represents a guaranteed minimum time; the time actually tolerated will usually be greater, and can be up to 2.125 times greater. (Note: selecting a value of zero samples effectively disables this function).

A terminating suffix is required (EN).

Examples:

```
OUTPUT 713;AE BTDP .02 EN      ! set  time to .02 ms or next highest discrete
                               ! value, for BAP measurements on sensor A
OUTPUT 713;BE BTDP .03 EN      ! set dropout time to .03 ms or next highest discrete
                               ! value, for BAP measurements on sensor B
```

3.21 Min/Max Power Value

The Min/Max feature monitors the measurements being taken, and maintains a continuously updated record of the highest and lowest values measured so far.

☛ **NOTE:** The Min/Max feature can only be used in the standard measurement collections modes (not in the fast modes).

3.21.1 Enabling the Min/Max Feature

The Min/Max feature is enabled or disabled by simple commands consisting of one of two function codes:

[MN0 or MN1]

Examples:

```
OUTPUT 713;MN1          ! Enable the Min/Max feature
OUTPUT 713;MN0          ! Disable the Min/Max feature
```

The MN1 command, like the LG command, has the effect of specifying logarithmic measurement units (dB or dBm). Like the PH0 and CR0 commands, this command will disable crest factor and peak hold measurements.

3.21.2 Reading the Min/Max Values

Min/Max values are read over the bus using simple commands consisting of one of two function codes:

[MIN or MAX]

MIN specifies that the current minimum measured value should be sent.

MAX specifies that the current maximum value should be sent.

Examples:

```
OUTPUT 713;MIN          ! Send the minimum measured value
OUTPUT 713;MAX          ! Send the maximum measured value
```

The Min/Max feature monitors the minimum and maximum powers as they are measured and displayed on the front panel. Transient drop-outs or spikes in the power may not be captured by this feature. If it is necessary examine transient or unusual events, the triggering capability of the peak power sensor, the fast measurement modes, or the Peak Hold feature may provide a better way to characterize the signal in question. The Min/Max feature monitors for the minimum and maximum power, but does not provide any feedback to the controller until a MIN or MAX command is received. To monitor for a limit violation, the Limits feature may be more useful (see Section 3.16).

The Min/Max feature returns the current Min/Max values as displayed on the front panel. A Min or Max commands does not initiate data collection in same manner as a trigger command, such as TR1. To get a good reading of Min/Max values, the procedure is:

1. Set up the signal being measured, and send MN1 to reset the Min/Max measurements.
2. Send TR2.
3. Read the TR2 data, or wait for the data ready service request (this allows for settling).
4. Send MIN or MAX.
5. Read the Min or Max value.

3.22 Offset Commands

Power offsets (in dB) can be specified, in order to provide a fixed correction for loss or gain in the test setup. The offset is added to, not a replacement of, the sensor's cal factors. All measurement data returned by the 8540C over the bus is corrected for the offset that has been specified (even in the fast measurement collection modes).

Be careful with offsets when you are using the analog outputs. The offset value is reflected in the analog output voltage. A change in the offset value may result in a measurement which is outside of the power range represented by the voltage range of the analog output.

3.22.1 Enabling/Disabling an Offset

The commands which enable and disable the offset function are based on the function codes OF0 and OF1:

[AE or BE] [OF0 or OF1]

[AE or BE] prefix specifies Sensor A or Sensor B.

[OF0] deactivates the offset; [OF1] activates the offset.

Examples:

```
OUTPUT 713;AE OF0          ! Disable offset for sensor A
OUTPUT 713;BE OF1          ! Enable offset for sensor B
```

3.22.2 Setting an Offset Value

The commands which specify the offset value are based on the OS function code:

[AE or BE] OS [n] EN

[AE or BE] specifies Sensor A or Sensor B.

[OS] indicates that an offset is being specified for the sensor.

[n] specifies the offset in dB. The value of n can range from -99.999 dB to +99.999.

A terminating suffix (EN) is required.

Examples:

```
OUTPUT 713;AE OS 20.00 EN      ! Set +20 dB offset for sensor A
OUTPUT 713;BE OS -15.12 EN     ! Set -15.12 dB offset for sensor B
```

☛ **NOTE:** A change to the offset of a sensor will reset any Peak Hold or Crest Factor measurement involving that sensor.

3.22.3 Measured Offset Entry

A measurement can be saved and used as an offset. The command format for this purpose is:

[AP, BP, AR, BR, AD, or BD] OS DO EN

The command begins with a function code which describes the measurement that is to be stored as an offset value. There are six possible function codes; they are interpreted as follows:

AP:A
BP:B
AR:A/B
BR:B/A
AD:A-B
BD:B-A

OS followed by DO indicates that the difference between the current offset and the current value of the measurement described in the prefix, is to be saved as an offset value.

A terminating suffix (EN) is required.

Examples:

```
OUTPUT 713;AP OS DO EN      ! Save measurement A as an offset
OUTPUT 713;BP OS DO EN      ! Save measurement B as an offset
OUTPUT 713;AR OS DO EN      ! Save measurement A/B as an offset
OUTPUT 713;BR OS DO EN      ! Save measurement B/A as an offset
OUTPUT 713;AD OS DO EN      ! Save measurement A-B as an offset
OUTPUT 713;BD OS DO EN      ! Save measurement B-A as an offset
```

3.23 Peak Hold

The Peak Hold feature causes the measured value to hold at the highest instantaneous power measured from the time the feature is enabled until it is reset (the measured value changes only when it is rising to a new maximum, or when it is reset).

The Peak Hold feature can only be used in the standard measurement collections modes (not in the fast modes), and only in a modulated measurement mode (MAP, PAP, or BAP). *Peak Hold is not recommended for use in combination with the VpropF function.*

3.23.1 Enabling the Peak Hold Feature

The Peak Hold feature is enabled or disabled by simple commands consisting of one of two function codes:

[PH0 or PH1]

Examples:

```
OUTPUT 713;PH1          ! Enable the Peak Hold feature
OUTPUT 713;PH0          ! Disable the Peak Hold feature
```

Like the MN0 and CR0 commands, this command will disable Crest Factor and Min/Max measurements.

3.23.2 Reading the Peak Hold Value

The Peak Hold value is read over the bus using a simple command:

PKH

Example:

```
OUTPUT 713;PKH          ! Send the peak hold value
```

The Peak Hold feature monitors the maximum power as it is measured, but does not provide any feedback to the controller until a PKH command is received. To monitor for a limit violation, the Limits feature may be more useful (see Section 3.16).

The Peak Hold feature returns the current held value as displayed on the front panel. A PKH command does not initiate data collection in same manner as a trigger command, such as TR1. To get a good reading of the Peak Hold value, the procedure is:

1. Set up the signal being measured, and send PH1 to reset the Peak Hold measurement.
2. Send TR2.
3. Read the TR2 data, or wait for the data ready service request (this allows for settling).
4. Send PKH.
5. Read the Peak Hold value.

3.24 Peak Power Sensor Commands (80350A Series)

Commands related to the peak power sensor are based on the function code PEAK.

3.24.1 Setting the Trigger Mode & Trigger Level

The command format for setting trigger modes and levels is:

PEAK [A or B] [INT or EXT] TRIG [n]

A or B specifies Sensor A or Sensor B.

[INT or EXT] specifies internal or external triggering.

TRIG indicates that a trigger level is being set.

[n] specifies the trigger level in units of dBm in the case of internal triggering, or volts in the case of external triggering.

Examples:

```
OUTPUT 713:PEAK A INT TRIG -10.00     ! Configure sensor A for internal triggering at
                                      ! a trigger level of -10.00 dBm

OUTPUT 713:PEAK B EXT TRIG 1.50       ! Configure sensor B for external triggering at
                                      ! a trigger level of 1.50 Vdc
```

The command format for selecting the CW mode is:

PEAK [A or B] CW

[A or B] specifies Sensor A or Sensor B.

CW specifies the CW mode.

Example:

```
OUTPUT 713:PEAK A CW                  ! Configure sensor A for CW measurements
```

3.24.2 Setting the Delay

A delay between the trigger and the actual measurement can be specified (in the CW mode, delay settings have no effect). The command format for setting the delay is:

PEAK [A or B] DELAY [n]

[A or B] specifies Sensor A or Sensor B.

DELAY indicates that a delay value is being set.

[n] is a numerical variable which specifies the delay in seconds. It has a range of -20E-9 (-20 ns) to 104E-3 (104 ms).

Examples:

```
OUTPUT 713;PEAK A DELAY 1.20E-6      ! Configure sensor A for a delay of 120 µs
OUTPUT 713;PEAK B DELAY 33.5E-9      ! Configure sensor B for a delay of 33.5 ns
```

☛ **NOTE:** The actual duration of the delay is the sum of this setting and the delay offset setting.

3.24.3 Setting the Delay Offset

An offset to the trigger delay can be specified (in the CW mode, delay settings have no effect). The command format for setting the delay offset is:

PEAK [A or B] OFFSET [n]

[A or B] specifies Sensor A or Sensor B.

OFFSET indicates that a delay offset value is being set.

[n] is a numerical variable which specifies the offset in seconds. It has a range of -20E-9 (-20 ns) to 104E-3 (104 ms). The default value of the offset is 0.

Example:

```
OUTPUT 713;PEAK A DELAY 1.20E-6      ! Configure sensor A for a delay offset of 120 µs
```

3.24.4 Reading Values

Trigger

The query format for trigger settings is:

PEAK [A? or B?]

[A? or B?] Sensor A or Sensor B.

Example:

```
OUTPUT 713;PEAK A?          ! Query the current sensor A trigger setting
ENTER 713;TRIG$             ! Enter the returned string into the string variable TRIG
```

The possible replies to the query are CW, INT_TRIG, and EXT_TRIG.

Delay and Delay Offset

The query format for delay and delay offset settings is:

PEAK [A or B] [DELAY? or OFFSET?]

[A or B] specifies Sensor A or sensor B.

[DELAY?] indicates that delay is being queried.

[OFFSET?] indicates that delay offset is being queried.

Examples:

```
OUTPUT 713;PEAK A DELAY?    ! Query the current delay setting for sensor A
ENTER 713;Delay             ! Enter the returned number into the variable Delay
ENTER 713;PEAK B OFFSET?    ! Query the current delay offset setting for sensor B
ENTER 713;Offset            ! Enter the returned number into the variable Offset
```

3.25 Peak Power Sensor Commands (80340A Series)

Commands related to the peak power sensor are based on the function code PEAK. (For the sake of backward compatibility with earlier Giga-tronics power meter designs, the command PULSE is accepted as a substitute for PEAK). The command format for setting the trigger mode is:

PEAK [A or B] [INT or EXT] [TRIG or DLYTRIG]

[A or B] specifies Sensor A or Sensor B.

[INT or EXT] specifies internal or external triggering.

[TRIG] indicates the immediate triggering mode.

[DLYTRIG] indicates the delayed triggering mode.

Examples:

```
OUTPUT 713;PEAK A INT TRIG      ! Configure sensor A for internal triggering
                                ! in the immediate triggering mode

OUTPUT 713;PEAK B EXT DLYTRIG   ! Configure sensor B for external triggering
                                ! in the delayed triggering mode
```

The command format for selecting the CW mode is:

PEAK [A or B] CW

[A or B] specifies Sensor A or Sensor B.

CW specifies the CW mode.

Example:

```
OUTPUT 713:PEAK A CW            ! Configure sensor A for CW measurements
```

3.26 Preset

The simple command PR can be used to preset the 8540C to its default conditions (alternatively, the IEEE-488.2 common command *RST can be used for the same purpose). The preset conditions of the instrument are outlined in Table 3-10.

Table 3-10. Preset (Default) Conditions

Sensors (all parameters apply to sensor A & sensor B		General	
Parameter	**Condition**	**Parameter**	**Condition**
Cal Factor	100.0%	Sensor Selection	Sensor A
Offset	0.00 dB	Calibrator	Off
Filter	AUTO	Default Sensor Prefix	Sensor A
Range	AUTO	Resolution	2 (0.01 dB)
Low Limit	0.000 dBm	Limits Checking	Off
High Limit	0.000 dBm	Max/Min	Off
Frequency	50 MHz	REL	Off
Duty Cycle	OFF, 1.000%	Trigger Mode	TR3
Measurement Mode	See Note 1	Group Execute Trigger Mode	GT2
		Display Function	Display Enable
		LED Peaking Meter Mode	Status
		Pulse Sensor Mode	Internal Trigger
		Measurement Units	See Note 2
		Sound	On
		Analog Output	Off

Notes:

1. The default measurement mode depends on the sensor type. For a CW sensor, the default is CW. For an 80401 sensor, the default is MAP. For a peak sensor, the default is INT TRIG. Regardless of the sensor type, all advanced features are turned off.

2. There is a slight difference between the preset conditions as set by a remote command, and as set from the front panel menus. This difference has to do with measurement units. If the 8540C is preset from the front panel, this sets the measurement units to dBm in all cases. If the 8540C is preset over the bus, this sets the measurement units to Watts in the case of 438 emulation, and has no effect at all in the case of 436 emulation; otherwise, it sets the measurement units to dBm.

   This distinction is made to accommodate differences between emulations for remote programming purposes without affecting the benchtop user.

3.27 Relative Measurements

In the relative measurement mode, the 8540C saves the current measured power level as a reference. Subsequent measurements will be expressed relative to this reference level; the measurement units become dBr (for logarithmic measurement) or % (for linear measurement).

The simple commands associated with relative measurement modes consist of one of three function codes:

[RL0 or RL1 or RL2]

[RL0] deactivates the relative measurement mode.

[RL1] activates the relative mode, and causes the current measured level to be recorded as the reference level.

[RL2] activates the relative mode and causes the reference level that was saved under a prior RL1 command to be used as the reference level. That is, if the relative mode is activated by an RL1 command, and then deactivated by an RL0 command, the effect of RL2 is to restore the reference level that was saved in response to the RL1 command.

Examples:

```
OUTPUT 713;RL0          ! Disable the relative mode
OUTPUT 713;RL1          ! Enable the relative mode; save the current level as a reference
OUTPUT 713;RL2          ! Replace the current reference level with the previous level
```

3.28 Resolution

Commands which specify measurement resolution are based on the function code RE. The command format is:

RE [a] EN

RE indicates that resolution is being set.

[a] indicates the resolution with four values allowed (0, 1, 2, and 3). These specify the number of digits to the right of the decimal point.

A terminating suffix (EN) is required.

☛ **NOTE:** This command affects measurements shown on both lines of the display.

Examples:

```
OUTPUT 713;RE 0 EN      ! Set the display resolution to xx.
OUTPUT 713;RE 1 EN      ! Set the display resolution to xx.x
OUTPUT 713;RE 2 EN      ! Set the display resolution to xx.xx
OUTPUT 713;RE 3 EN      ! Set the display resolution to xx.xxx
```

3.29 Sensor Selection

Six simple commands (consisting of one of six function codes) specify how the sensors are used:

[AP BP AR BR AD BD]

Examples:

```
OUTPUT 713;AP          ! Measure sensor A
OUTPUT 713;BP          ! Measure sensor B
OUTPUT 713;AR          ! Measure A divided by B
OUTPUT 713;BR          ! Measure B divided by A
OUTPUT 713;AD          ! Measure A less B
OUTPUT 713;BD          ! Measure B less A
```

These commands, like the prefixes AE and BE, are sensor-specific, and cause the 8540C to assume that subsequent commands are intended for the same sensor unless they specify otherwise. Also, these commands (like the MN0, CR0, and PH0 command) have the effect of disabling Min/Max monitoring, Crest Factor, and Peak Hold.

3.30 Status

3.30.1 Status Byte Message

The power meter responds to a Serial Poll Enable (SPE) bus command by sending an 8-bit byte when addressed to talk. If the instrument is holding the SRQ bus control line true (issuing the Require Service message), bit position 6 in the Status Byte and the bit representing the condition causing the Require Service message to be issued will both be true. The bits in the Status Byte are latched, but can be cleared by sending the Clear Status (CS) program code.

Table 3-11. Status Byte and Service Request Mark

Bit	Weight	Service Request Condition
7	128	0
6	64	RQS bit Require Service
5	32	Event Status
4	16	Over/Under Limit
3	8	Measurement or Cal Zero Error
2	4	Entry Error
1	2	Cal/Zero Complete
0	1	Data Ready

The condition indicated in Bits 1-5 must be enabled by the Service Request Mask to cause a Service Request Condition. The mask is set with the @1 program code followed by an 8-bit byte, or the *SRE program code followed by three ASCII characters. The value of the byte is determined by summing the weight of each bit to be checked (the three ASCII characters are the value of the byte in decimal). The RQS (bit 6) is true when any of the conditions of bits 1-5 are enabled and occur. Bits remain set until the Status Byte is cleared.

Examples:

```
OUTPUT 713;CS                 ! clear SRQ and status byte
   or
OUTPUT 713;*CLS               ! clear SRQ and status byte (488.2)
State = SPOLL(713)            ! read status byte
   or
OUTPUT 713;*STB?              ! ask for status byte (488.2)
ENTER 713;State               ! read status byte with 3 ASCII digit numbers
OUTPUT 713;@1;CHR$(4)         ! set service request mask to 4
   or
OUTPUT 713;*SRE004            ! set service request mask to 4
OUTPUT 713;RV                 ! ask for service request mask
   or
OUTPUT 713;*SRE?              ! ask for service request mask (488.2)
```

3.30.2 Event Status Register

The Event Status Register (ESR) is essentially a second status byte; it is an 8-bit byte, described in the table below. When a specified event occurs, the ESR bits are set true; they can be read by sending an *ESR? command. When the command is received, the 8540C responds by sending an ASCII 3 digit value (from 0 to 255) that describes the present state of the register. This ASCII value is arrived at by summing the weighted values of the transmitted bits.

The ESR bits consist of the following:

Power On	This bit will always be set.
Command Error	This bit is set when an improper GPIB code is sent to the instrument. The command WT would be considered a command error, for example.
Execution Error	When incorrect data is sent to the instrument, this bit will be set. For example, the command FR-1.0MZ would be considered an execution error.
Device Dependent Error	Errors 1 through 49 are measurement errors, and will set this bit true whenever they occur.

If an ESR bit is set true, this causes bit 5 of the Status Byte to be set only when a corresponding bit in the Event Status Enable Register is enabled. This register is similar to the Service Request Mask, in that it can be used to specify which bits in the ESR register will set bit 5 of the Status Byte.

The Event Status Enable Register is set by sending the program code *ESE, followed by an ASCII 3 digit value (the value is determined by summing the weights of the bits to be checked). To read the current setting of the Event Status Register, send the command *ESE?. The 8540C sends an ASCII 3 digit value that describes the current state of the register (the value is determined by summing the weights of the bits that are set).

Table 3-12. Event Status & Event Status Enable Register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Power On	0	Command Error	Execution Error	Device Dependent Error	0	0	0

3.30.3 Status Message

```
OUTPUT 713;SM                ! ask for status message
ENTER 713;Statusmess$        ! read status message
```

Status Message Output Format

The output format is as follows:

AAaaBBCCccDDddEFGHIJKLMNOP<CR><LF>

AA	Measurement Error Code
aa	Entry Error Code
BB	Operating Mode
CC	Sensor A Range
cc	Sensor B Range
DD	Sensor A Filter
dd	Sensor B Filter
E	Measurement Units
F	Active Entry Channel
G	Oscillator Status
H	REL Mode Status
I	Trigger Mode
J	Group Trigger Mode
K	Limits Checking Status
L	Top Line Limits Status
M	Bottom Line Limits Status
N	Offset Status
O	Duty Cycle Units/Status
P	Measurement Units
<CR>	Carriage Return
<LF>	Line Feed

Each letter in the Status Message Output Format denotes a single ASCII character. For more information on the individual elements of this format, see the tables on the following pages.

Elements of the Status Message Output Format

Table 3-13. Error Code Returned in Position AA

Error Code	Message	Notes
00	All OK	
01	Cannot zero sensor A	Ensure no RF power to sensor A
02	Cannot zero sensor B	Ensure no RF power to sensor B
03	Sensor A not connected to Calibrator	Connect sensor A to Calibrator
04	Sensor B not connected to Calibrator	Connect sensor B to Calibrator
05	Cannot Cal Sensor A	Check sensor A connection to Calibrator; reference must be 1.00 mW.
06	Cannot Cal sensor B	Check sensor B connection to Calibrator; reference must be 1.00 mW.
21	Over limit	An over-limit condition has occurred (for either the top or bottom line of the display)
23	Under limit	An under-limit condition has occurred (for either the top or bottom line of the display)
26	Sensor A unable to synchronize burst average power measurements to a pulse stream.	Check measurement setup and RF signal.
27	Sensor B unable to synchronize burst average power measurements to a pulse stream.	Check measurement setup and RF signal.
31	No sensor on Channel A	Connect sensor A, or change channels if B is connected.
32	No sensor on Channel B	Connect sensor B, or change channels if A is connected.

Table 3-14. Error Code Returned in Position aa

Error Code	Message	Notes
00	All OK	
50	Entered Cal Factor out of range	Enter value between 1.0% and 150.0%
51	Entered Offset out of range	Enter value between -99.999 dB and +99.999 dB
53	Entered average number out of range.	Enter valid average number.
54	Entered recall memory number out of range.	Enter valid recall memory number between 0 and 20.
55	Entered store memory number out of range.	Enter valid store memory number between 1 and 20.
56	Entered ref cal factor out of range.	Enter ref cal factor between 50% and 120%.
57	Memory error or battery failure.	Check battery or perform cal procedure to check memory.
60	Unable to set requested measurement mode or sensor measurement because sensor A is unattached or uncalibrated.	This may be due to receipt of a MAP, PAP, BAP, DC1, or DY command.
61	Same as Error 60 above, but for sensor B.	
62	Unable to set up sensor A to perform a modulated measurement (MAP, PAP, or BAP), because the sensor is not a modulated sensor or because the instrument is currently set up to perform two-sensor measurement. OR: Unable to modify a BAP measurement because the sensor is not a modulated sensor.	This may be set due to receipt of a MAP, BAP, DC1, DY, BSTE, BSPE, or BTDP command. When one sensor is set up to perform a modulated measurement, only one sensor at a time may perform measurements (two-sensor operation is prohibited).
63	Same as Error 62, but for sensor B.	
67	Unable to activate Peak Hold or Crest Factor features.	This may be set due to receipt of a CR1 or PH1 command. Peak Hold and Crest Factor can be enabled only in MAP, PAP, or BAP modes.
68	Unable to initiate fast measurement collection mode.	Verify sensor and measurement mode selections.
69	Unable to perform a two-sensor operation because one sensor is currently set up to perform a modulated measurement (MAP, PAP, or BAP).	This may be due to receipt of an AD, AR, BD, or BR command.
70	Entered peak sensor A data error.	Check entered data.
71	Entered peak sensor B data error.	Check entered data.
72	Entered peak sensor A delay out of range.	Check entered delay.
73	Entered peak sensor B delay out of range.	Check entered delay.
74	Entered peak sensor A trigger out of range.	Check entered trigger value.
75	Entered peak sensor B trigger out of range.	Check entered trigger value.
76	Sensor EEPROM data entry has error.	Check entry data.
77	Sensor A does not exist.	Check sensor A. This error code refers only to the EEPROM command.
78	Sensor B does not exist.	Check sensor B. This error code refers only to the EEPROM command.
79	Measurement settling target for auto-average mode is out of range.	Value must be 0.10% to 100.00%.
81	Duty cycle out of range.	Value must be between 0.001% and 99.999%.
82	Frequency value out of range.	Value must be between 0 Hz and 100 GHz.
85	Resolution value out of range.	Value must be between 0 and 3.
90	GPIB data parameter error.	Check, then enter with valid prefix.
91	Invalid GPIB code.	Check, then enter with correct code.

Table 3-15. Other Codes in the Status Message

Position	Significance	Codes	
BB	Operating Mode	00 = Sensor A 01 = Sensor B 02 = A/B 03 = B/A 04 = A-B 05 = B-A 06 = Zeroing A 07 = Zeroing B	08 = Cal A 09 = Cal B 10 = Ext Cal A 11 = Ext Cal B 20 = Peak A delay 21 = Peak B delay
CC & cc	Sensor A range & Sensor B range	Manual Range: 01 = 1 02 = 2 03 = 3 04 = 4 05 = 5	Auto Range: 11 = 1 12 = 2 13 = 3 14 = 4 15 = 5
DD & dd	Sensor A filter & Sensor B filter	Manual Filter: 00 = 0 01 = 1 02 = 2 03 = 3 04 = 4 05 = 5 06 = 6 07 = 7 08 = 8 09 = 9	Auto Filter: 10 = 0 11 = 1 12 = 2 13 = 3 14 = 4 15 = 5 16 = 6 17 = 7 18 = 8 19 = 9
E	Measurement Units	0 = Watts, 1 = dBm	
F	Active Entry Channel	A = A, B = B	
G	Calibrator Output Status	0 = Off, 1 = On	
H	REL Mode Status	0 = Off, 1 = On	
I	Trigger Mode	0 = Freerun, 1 = Hold	
J	Group Trigger Mode	0 = GTO, 1 = GT1, 2 = GT2	
K	Limits Checking Status	0 = Disabled, 1 = Enabled	
L	Top Line Limits Status	0 = In limits 1 = Over high limit 2 = Under low limit	
M	Bottom Line Limits Status		
N	Offset Status	0 = Off, 1 = On	
O	Duty Cycle	0 = Off, 1 = On	
P	Measurement Units	0 = Watts, 1 = dBm, 2 = %, 3 = dB	

3.31 Store and Recall

The instrument's current configuration can be saved in a register for later recall.

3.31.1 Saving a Configuration

The commands for saving the instrument state are based on the ST function code:

ST [r] EN

ST is the Save function code.

[r] identifies the register in which the instrument's configuration is to be saved (and from which it can later be retrieved). The value of [r] can be any number from 1 through 20.

A terminating suffix (EN) is required.

Example:

```
OUTPUT 713;ST12EN          ! Save the current instrument configuration in register 12
```

☛ **NOTE:** Register 0 contains the previous state of the instrument; to recover from an accidental preset, recall the configuration from that register.

3.31.2 Retrieving a Configuration

The commands for recalling a configuration from a register are based on the RC function code:

RC [r] EN

RC is the Recall function code.

[r] identifies the register in which the instrument's prior configuration has been saved and from which it is now to be retrieved. The value of [r] can be any number from 0 through 20.

A terminating suffix (EN) is required.

Example:

```
OUTPUT 713;RC3EN           ! Recall the configuration that was saved in register 3
OUTPUT 713;RC0EN           ! Recall the prior configuration (this command recovers
                           ! from configuration errors)
```

3.32 Units

Logarithmic or linear measurement units are specified by simple commands consisting of the function codes LG and LN.

Examples:

```
OUTPUT 713;LG              ! set Log units (dB or dBm)
OUTPUT 713;LN              ! set Linear units (Watts or %)
```

These commands affect all types of measurements, except for the fast measurement collection modes. These modes always return measurement readings in dBm.

3.33 VpropF Feature

The VpropF feature (voltage proportional to frequency) provides a means of indicating to the 8540C the approximate frequency of the signal that it is measuring, so that the appropriate cal factor can be applied. The frequency is indicated by means of a variable voltage input. The 8540C reads the voltage as an expression of frequency, and applies the proper cal factor from the table stored in the sensor EEPROM (interpolating for frequencies that fall between the stored values).

In order for the 8540C to interpret the input voltage input correctly, it is necessary to specify the starting point (that is, the frequency at zero volts) and the slope (the rate at which voltage increases with frequency).

3.33.1 Enabling & Disabling VpropF

Commands related to the VpropF function are based on the function code VpROPF. The command format, for purposes of activating or deactivating the VpropF feature, is as follows:

VPROPF [A or B] STATE [ON or OFF]

[A or B] specifies Sensor A or Sensor B.

STATE indicates that the VpropF feature is being enabled or disabled.

[ON or OFF] enable or disable the VpropF function.

Examples:

```
OUTPUT 713;VPROPF A STATE ON ! Enable VpropF for sensor A
OUTPUT 713;VPROPF B STATE OFF! Disable VpropF for sensor B
```

3.33.2 Configuring VpropF

The command format, for purposes of configuring the VpropF feature, is as follows:

VPROPF [A or B] MODE [f] [s]

[A or B] specifies Sensor A and Sensor B.

MODE indicates that the VpropF feature is being configured (that is, the start frequency and slope are being specified).

[f] indicates the start frequency (the frequency at zero volts), expressed in Hz. The start frequency must be less than the upper frequency limit of the sensor.

[s] indicates the slope of the VpropF (the ratio of input voltage to input frequency), expressed in V/Hz. The value must be between 1E-12 and 1E-8.

Example:

```
OUTPUT 713;VPROPF A MODE 2.00E9 1.00E-9   ! Configure the VpropF feature for sensor A
                                          ! as follows:
                                          ! 2.00 GHz start frequency
                                          ! 1.00 Volt per GHz slope
```

3.34 Zeroing

The commands used for zeroing of a sensor are based on the function code ZE. The command format is:

[AE or BE] ZE

[AE or BE] prefix specifies Sensor A or Sensor B.

Examples:

```
OUTPUT 713;AEZE          ! Zero sensor A
OUTPUT 713;BEZE          ! Zero sensor B
```

☛ **NOTE:** If the sensor is attached to an RF source, the source must be turned off prior to zeroing. Zeroing before calibration is not necessary; zeroing of the sensor is part of the sensor calibration process.

The following is an example of how to zero a sensor with the GPIB program. The service request feature determines when the zero has completed; this results in the quickest zeroing routine.

Examples:

```
Zero:                          ! zero routine
ON INTR 7 GOSUB Srq_interrupt  ! setup serial poll interrupt jump location
ENABLE INTR 7;2                ! enable SRQ interrupts
OUTPUT 713;*SRE010             ! set service request mask to 2
OUTPUT 713;CS                  ! clear status byte
OUTPUT 713;ZE                  ! start zero
Flag=0                         ! reset control flag
WHILE Flag=0                   ! wait while zeroing
END WHILE
RETURN
Srq_interrupt:                 ! SRQ interrupts jump here
OUTPUT 713;*STB?
ENTER 713;State
IF BIT(State, 1) THEN
   PRINT GOOD ZERO
   ELSE
        IF BIT(State, 3) THEN
            PRINT BAD ZERO
            ENDIF
ENDIF
OUTPUT 713;CS                  ! clear status byte
Flag=1                         ! set control flag true
RETURN
```

4

Theory of Operation

4.1 General

This chapter provides a functional description of the circuits used in Series 8540C power meters. The circuits are contained in the four printed circuit boards listed in Table 4-1:

Table 4-1. 8540C Circuit Board Assemblies

Reference Designation	Title	Assembly Drawing Part #	Schematic Part #
A1	CPU PC Bd Assembly	21693	21694
A2	8541C Analog PC Bd Assembly	30164	30165
A2	8542C Analog PC Bd Assembly	30173	30165
A3	Front Panel PC Bd Assembly	21229	21230
A4	LCD Display Assembly	21240	NA

The 8540C Interconnection Diagram (see drawing no. 30161 on page 8-3) shows how the assemblies are connected to one another. Also see Figure 4-1 for a block diagram of the CPU board interconnection. Most of the electrical circuitry resides on the CPU PC Board (A1) and the Analog PC Board (A2). The CPU interfaces with the Analog assembly through connection A1J1/A2P1. The CPU also connects to the Front Panel assembly (A3) that provides the keyboard interface and the LED status indicators, and to the LCD display assembly (A4).

Various cable connections are provided on the 8540C rear panel. The GPIB connector communicates with the CPU board through connector J3. Three rear panel BNCs connect to the CPU board, and two rear panel BNCs connect to the Analog board. J8 on the CPU assembly is used for in-house development and testing, and for the Time Gating (Option 11) PC board.

The LCD Display (A4) is an OEM purchased part and does not include a circuit schematic in this manual.

4.2 CPU PC Board (A1)

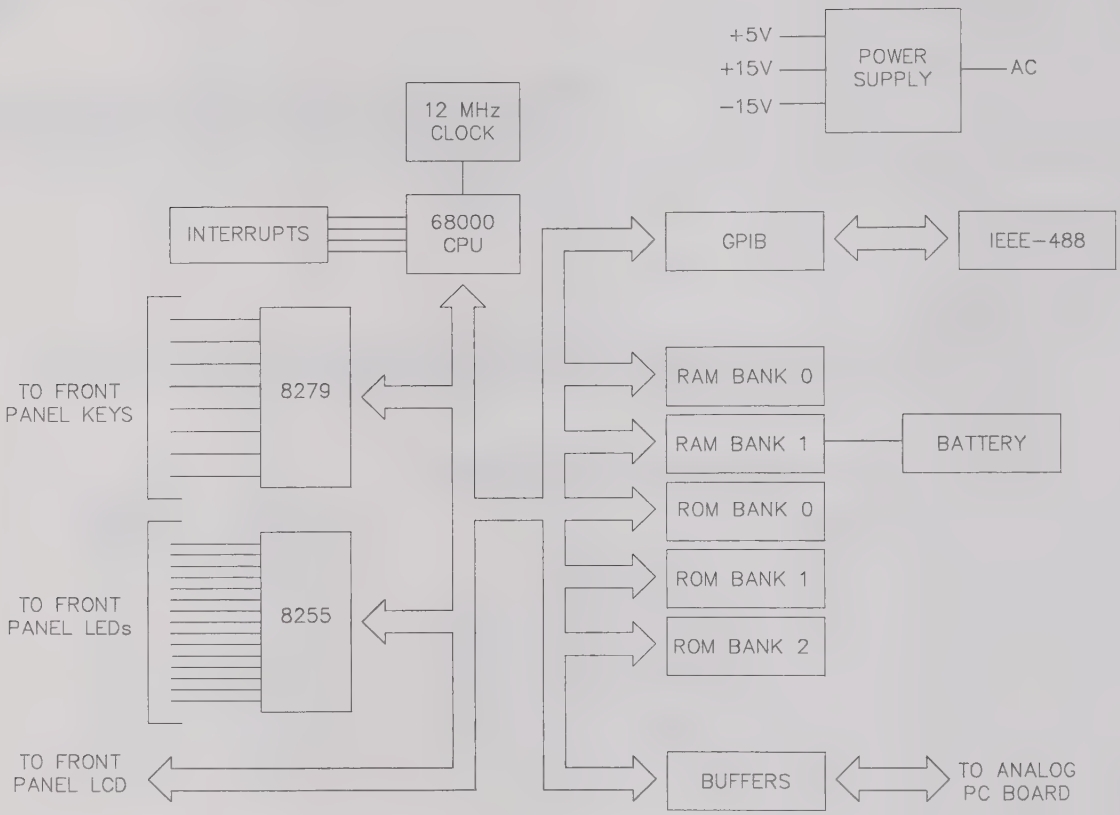

Figure 4-1. CPU Block Diagram

4.2.1 Power Supply

As shown in the Interconnection Diagram in Chapter 8, ac main power (110 or 220 V) is applied to transformer T1. One 8.4 Vac and 19 Vac outputs from T1 are supplied to the dc power supply on the CPU board. The dc power supply produces the +5 Vdc and +15/-15 Vdc required by various circuits in the meter.

The T1 transformer's 8.4 Vac and 33 Vac enter the dc supply through J9. CR6 rectifies the 8.4 Vac to an unregulated 8 Vdc. C54 and C6 provide filtering, and the unregulated voltage is applied to regulators U37 and U38. The U37 regulator supplies 5 V (at 0.5 A) required by the front panel LCD display's backlight. U38 supplies 5 V required by all of the digital circuitry. TP12 and TP13 are available to test the level of the 5 V supply. CR7 rectifies the unregulated voltage of the +16.5/-16.5 V filters which is applied to U39 and U40 through C9 and C12. U39 is the +15 V regulator, and U40 is the -15 V regulator. TP14 and TP15 are available to test these voltages.

4.2.2 Battery Back-Up

A 3.6V lithium battery is used for non-volatile RAM backup for system configuration storage registers. TP16 & TP17 and R29 are used as a current draw monitor for the battery. If the battery is supplying too much current, it will be shown as the voltage drop across R29. Typically, the non-volatile RAMs should draw about 3 µA from the battery. This will produce 3 mV across TP16 & 17.

4.2.3 Circuit Description

Y1 (shown in the upper left corner of page 8-9) is a 24 MHz crystal oscillator that provides the main clock signals for the circuitry. U1A is a divide-by-two counter that outputs 12 MHz. This 12 MHz is used by the 68000 microprocessor, U9, so that U9 is running at a 12 MHz clock speed. The clock is further divided down for other uses at U2. U2 also provides wait states when accessing peripherals. U17D/E/F and U16C&D provide U9 with decoding of the status lines for auto vector interrupts. U16A provides an upper data byte write signal, and U16B furnishes the lower data byte write signal.

The 68000 microprocessor (U9) is a 16-bit component with a high 8 bits and a low 8 bits. Most 8 bit peripherals operate using the low 8 bits with only those devices requiring more than 8 bits using the high 8 bit data. (e.g. the ROM and RAM use both upper and lower).

U4 is a PAL (Programmable Logic Device) that provides address decoding for RAM Banks 0 and 1, and ROM banks 0, 1, and 2. U4 pin 15 is a chip select for all peripherals. The signal from U4 goes to U18 which further decodes address signals into various port chip selects. The U4 and U2 ICs provide the wait state function. When U4 decodes ROM or RAM it immediately passes back DTAK via pin 12 of U9. When it encounters a peripheral device address (when pin 15 is low for the chip select), DTAK is held off until a signal is received on pin 1. The pin 1 signal comes from the wait state generation of U2. The sequence is: The address strobe comes on, U4 looks at the address lines and detects that it is a peripheral being addressed, and the chip select from U4 pin 15 goes to pin 2 of U2. U2A then starts counting down until pin 6 comes true (through jumper D) which happens 8 clock cycles later (a wait state of 8). The signal gets passed to pin 1, and then U4 passes DTAK (pin 12) to the U9 processor. By this method, various wait states can be generated with jumpers A, B, C, and D (1, 2, 3, and 4 wait states). (ROM and RAM are always 0 wait states so DTAK passes right through.)

The RAM 1 chip select is passed through U10 which is a nonvolatile RAM controller. This chip will only chip select to pass through from pin 5 to pin 6 if pin 8 has a valid 5 V of power supplied to it. When the power supply is off and pin 8 no longer has 5 V applied to it, U10 will automatically stop chip selects from passing through. It automatically routes pin 2's power (instead of routing pin 8's power) from the backup battery to pin 1 which is the battery voltage for RAM Bank 1. This means that when power is turned off, no memory is lost and chip select is disabled to stop any memory writes from occurring that could corrupt the data.

U22 provides the reset for the processor, U9. When the power is turned on U9 asserts the reset line, pin 5, for 250 ms. That signal is buffered by U20A&B (open collector drivers) that cause the reset of U9. When U9 is reset it reasserts pin 18, buffered by U17A, which provides the reset signal. This can be tested at TP8.

R2 and R3 divide down the unregulated supply voltage and provide pin 1 of U22 with a threshold voltage. When the power supply has been turned off, U22 will detect this by seeing a voltage change in the pin 1 voltage. When the voltage drops, it will assert the interrupt, pin 7 of U22. This tells U9 that the power is being turned off, and that it should complete any current operations before the power is removed.

U21 provides encoding of the interrupt signals by an 8 line to 3 line encoding routine. Interrupt 0 is not used. Interrupts 1 through 7 can be enabled or disabled by removing or replacing jumpers A through G. Jumper H disables all interrupts so that it is not necessary to remove A through G if this is desired. Interrupt 1 occurs when a sensor is connected or disconnected. Interrupt 2 is used with the rear panel BNC trigger. Interrupt 3 occurs when any GPIB bus activity is in progress. Interrupt 4 occurs when a front panel key is depressed, and interrupts 5 and 6 are available for programmable timing provided by U26 (currently not used). Interrupt 7 is used when the power supply is shut down.

U26 is one of three programmable times in the system. These timers divide down the supply clock, clock 0, 1, and 2, which are all 0.75 MHz clocks that can be programmed to provide different clock signals. Presently, U26 is not used (for future development).

U8 (a Texas Instrument 9914 GPIB controller) is a peripheral chip used for GPIB affectivity. U6 and U7 provide buffering of GPIB signals before they are sent over the bus. Pin 1 of U7 programs the GPIB bus to be a master controller or a talker/listener device. Presently, only talker/listener modes are used in the

8540C Series meters. U23 is an 8279 keyboard controller that provides keyboard scanning and key press detection. It also provides an 8-key buffer. U19 is a 3 to 8 line decoder used for column and row scanning which are detected by pins 1, 2, 38, 39, and U23. When U23 detects a key press, it asserts interrupt 4 from U24A. U22, U23, U24, and U25 provide pull ups for the keyboard matrix. U25 is a PIA (Peripheral Interface Adapter) used to program the 20 front panel LEDs.

Pin 10 of U25 provides drive for the single LED on the CPU board, DS1, that is used for internal testing. Pins 11, 12, and 13 are auxiliary signals which are presently not used. The battery interfaces with U27 and U28. Each of these devices typically draw 1 µA, for a total battery dissipation of approximately 3 µA.

There are additional signals present at U3. Pin 4 drives Q1 which, in turn, drives a piezo-electric beeper for front panel audio signals. U3-3 resets the trigger latch, U1-2 is an output buffered by U24E which is the RF blanking signal used to turn off the source RF during zeroing. This is done automatically through J7. Pin 18 is the trigger latch input from U1B.

The following is the normal sequence of operation for the external trigger signal: The trigger input signal is applied through the TRIGGER INPUT BNC connector, J4, on the rear panel. R11, R12, CR2, and CR13 provide input protection for U24B which buffers the trigger signal and acts as a Schmitt trigger. The trigger can either assert Interrupt 2 to provide edge detection, or be latched by U1B for level detection. U1B can be set by asserting pin 13, and then unasserting pin 13 which sets the latch ready for a new trigger signal, which is read by pin 9. U3-19 is an input from U24D which is for future use. R11, R14, CR4, and CR5 also provide input protection.

The CPU Board connects to the Analog Board via J1. Bus signals are buffered by U12 and U13 which are bidirectional devices that buffer the 16 data lines, D0-D15. These tri-state buffers are only active when the Analog Board is chip selected via CS Analog (pin 12 of U18). All 16 data lines are sent to the Analog Board, but only 4 addresses (A0 - A3) are buffered by U14A. Reset, not read/write, read/not write, and the lower data write signals are also buffered.

The Chip Select Analog is further decoded into 8 additional chip selects for the Analog Board by U15 which then outputs ACS0 through ACS1.

Referring to Sheet 2 of the A1 Circuit Schematic (drawing #21694), the DIP sockets that the ROMs and RAMs are mounted in are configured to accept either 512K or 1M devices. 512K devices are 28 pin components that have to go into 32 pin sockets. When this is done, pins 1, 2, 31, and 32 are not used, which means that the 512K device is occupying pins 3 through 30 of the socket. The difference in address decoding between 512K and 1M devices is provided by PAL U4.

The ROM and RAM banks are word addressed. The necessary reads and writes are done in 16 bit words. Each chip in the bank provides 8 bits (or 1/2 of the word). For example, ROM Bank 0 is composed of U35 and U36. U35 is the lower 8 bits, and U36 is the upper 8 bits of data. U33 and U34 are ROM Bank 1, and U31 and U32 are ROM Bank 2.

RAM Bank 0 is only loaded if Option 02 (128K Buffer) is specified. This option provides more memory buffer for the fast measurement collection. RAM Bank 0 is volatile RAM (loses memory when power is turned off). RAM Bank 1 is composed of U27 and U28 which are non-volatile because they are connected to the backup battery.

Connection J6 interfaces the LCD display with the CPU Board. R26, R27, and R28 provide current limiting for the LED backlight of the display (draws approximately 1/2 Amp). The resistor divider network, R16, is used to provide contrast adjustment for the LCD display. U11B buffered by U24F provides a decoded data strobe.

4.3 Analog PC Board (A2)

4.3.1 Circuit Description

Sheet 1 of the Analog Circuit Schematic (drawing #30165) shows the Channel A sensor amplifier used with both the 8541C and 8542C. Sheet 2 of Analog Circuit Schematic covers the Channel B sensor amplifier circuits used with the 8542C only. Also see Figure 4-2 for a block diagram of the Analog board interconnection. Since these are essentially duplicate circuits (the differences will be described), this discussion will mainly focus on the Sheet 1 components. The sensors are connected from the front panel through W6J1 which enters the Analog Board through J1 for sensor A and J2 for sensor B. The detected dc voltage from the sensor is a differential voltage applied to pins 3 and 4 of J1. This differential voltage goes to U25, which is a FET chopping circuit. The outputs are pins 7,10 and 2,15 of U25. An incoming signal can either be fed straight through or inverted. The signal is fed straight through when CHAMCHP is high; it is fed through in the inverted mode when CHAMCHP is low. This provides chopper stabilized amplification when low power signals are being received by switching the FET switch from the inverting to non-inverting mode and back again at a rate of 300 times per second.

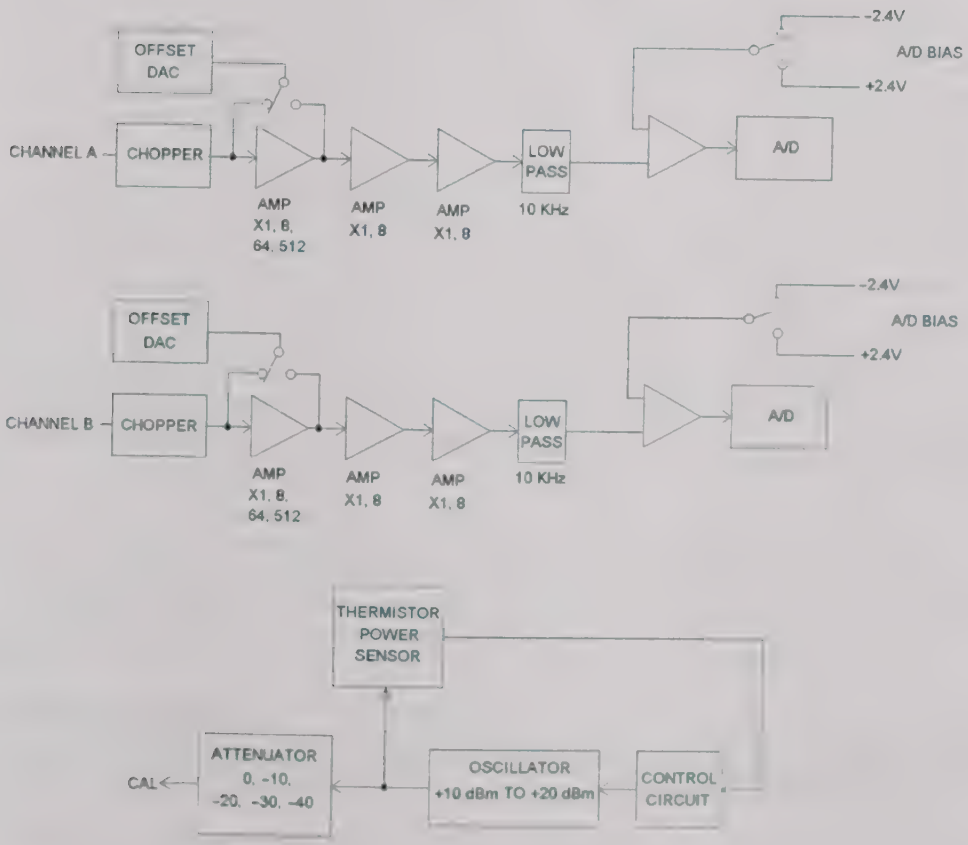

Figure 4-2. Analog PC Block Diagram

There are three stages of gain in the analog processing chain. All three stages are gain programmable and fully differential. Stage 1 is made up of two identical composite amplifiers. The positive half of stage 1 is composed of amplifiers U29, U46, U48 and RF JFETs Q13-16. U29 is a precision amplifier, which handles the dc and low frequency portion of the signal. The high frequencies are handled by U48, which is buffered by the two JFET source follower stages and ac coupled at about 30 Hz by C94 and C98.

The outputs of U29 and U48 are combined in U46, a high speed unity-gain buffer. The gain of the stage is selected by feeding the output back through different points on the resistor ladders. Analog switch U31 connects different points on the resistor ladders back to the inverting input of the composite amplifier. The resistor ladder consisting of R12, R25, R26, R36 and R270 is used for gains of 1, 8, and 64. The ladder made up of R21, R112 and R190 is used for the 512 gain setting.

The U47 analog switch performs two functions. For low bandwidth sensors such as 80300 or 80400, the high amplifier is switched out to reduce noise and achieve good pulse response at high gain. The other half of U47 switches in band-limiting resistor R42 when the high-speed amplifier is switched in and it is set for unity gain.

Stages 2 and 3 are identical differential amplifiers. Each can be set for gains of 1 and 8. For stage 2, analog switch U62 selects one of two points on the resistor ladder consisting of R43, R243 and R145. C231 and C246 on stage 3 limit the bandwidth when that stage is set to a gain of 8.

An offset voltage from DAC, U17 (sheet 3) is injected into the amplifier chain at two different points. For all but the highest gain setting of stage 1, the offset is injected at the input of stage 2. When stage 1 is set for a gain of 512, the offset is injected at the input to stage 1. Analog switch U56 routes the offset voltage tot he proper path. U54C and B buffer the offset voltage path to stage 2 input. U54A and D buffer the path to stage 1 input. U56 switches the deselected path to analog ground so that no offset or noise is injected at that point.

Sheet 6 of the A2 Circuit Schematic shows the last stage in the analog chain and the analog-to-digital converter. U26 is a unity gain differential-to-single-ended stage, which drives the input of the A/D converter, U91. A bias voltage from amplifier U25 is also summed into U26. This bias voltage sets the A/D input at -2.4V. The A/D input voltage range is -2.5 V to +2.5 V. The bias voltage allows negative excursions in voltage due to noise. When the chopper is enabled, analog switch U90 synchronously alternates the bias voltage between -2.4V and +2.4V. This allows the A/D to measure the inverted signals during chopping. The bias voltage is derived from the A/D 2.5 V reference voltage using resistive dividers R63 and R68, and R73 and R261 in the non-inverted and inverted modes respectively.

Refer to Sheet 2 (Channel B) of the A2 Circuit Schematic (drawing #30165) which is exactly the same as Channel A (with different component numbers).

Each detector has a thermistor included in its housing so that the power meter can read the temperature of the sensor. The voltage from that thermistor is applied through J1-J6 (for channel A) and amplified by a gain of 2 by U39D. Channel B sensor voltage comes through J2-J6 and is amplified by U39A. The amplified versions of the thermistor voltages are applied to different inputs of the multiplexed A/D, U22 (sheet 3). The software continuously monitors those inputs to check for the presence of a sensor. When a sensor is present, the software uses the thermistor voltage in a temperature compensation algorithm.

U22 also reads the voltage from the J3 VpropF connector. CR15 provides input protection and U38A is a unity-gain buffer. The output of U38A is applied to the U22 A/D through voltage divider R51 and R52. This attenuates the maximum VpropF voltage of 10V down to the 2.5 V that the A/D requires. U23 is a 5 volt regulator and supplies U22 with Vdd.

The sensors also have EEPROMs that connect to the system through a serial interface. Channel A uses J1-13 for the clock and J1-12 for the data. This is a bidirectional device wherein data needs to be written to the sensor and also read to the sensor. U41:2 buffers incoming data, and U41:3 buffers outgoing data. Q2 provides the necessary open collector interface. U18 supplies the clock during a read or write action. The clock signal is buffered by U41:1. Channel B has a duplicate circuit consisting of U41:3,4,5 and Q3. DC supplies of +5 V and ±12V are also routed to the sensors. The 12V supplies are routed through RT3 and RT4 which are used to provide solid state fusing in case of any shorts. These are resettable solid state

fuses which do not need to be replaced. The +5 V can be switched on and off. This is buffered by Q8 which can enable or disable Q1. U113:1 and :2 buffer sensor control lines for gain and chop respectively. U113:3 and :4 perform the same function on channel B.

4.3.2 Analog Board Control Lines

This section describes the various control lines on the analog board. The names of the control lines are identical for channels A and B except for the letter B, which is shown in parenthesis.

Stage 1 Gain

Control of stage 1 gain requires setting two sets of switches. One set of switches sets the gain. The control lines are CHA(B)MX1A1 and CHA(B)MX!A0 and come from U104. The other set of switches adjusts the frequency compensation for the amplifier in unity gain to keep it reliably stable, and disconnects the high speed amplifier for low bandwidth sensors. The control line CHA(B)COMP controls the compensation of stage 1. CHA(B)WBWR controls the connectivity of the high speed amplifier. These control lines come from U21. The following defines the settings and gain of Stage 1.

CHA(B)MX1A1	CHA(B)MX1A0	Gain	CHA(B)COMP	CHA(B)WBWR
		80600 and Higher Sensors		
0	0	512	0	0
0	1	64	1	0
1	0	8	1	0
1	1	1	0	0
		All Other Sensors		
0	0	512	0	1
0	1	64	1	1
1	0	8	1	1
1	1	1	0	1

Stages 2 And 3 Gain

Each of these gain stages has its own gain setting switch. Control line CHA(B)MX3A1 controls stage 2 gain, and CHA(B)MX3A0 controls stage 3 gain. These control lines come from U21. The following defines the settings and gain of stages 2 and 3.

CHA(B)MX3A1	CHA(B)MX3A0	Stage 2 Gain	Stage 3 Gain
0	0	8	8
1	0	1	8
1	1	1	1

CW Filter (Gain Range 6)

This filter is switched in (logic high) when all gain stages are at maximum gain. Its control line, CHA(B)FILT, is a 4-input NAND function of the four gain control lines. This control lines comes from U21.

Chopping

There are two control lines for chopping. The CHA(B)MCHP line performs the chopping function by switching the U28 analog switch (channel A). This control line comes from U104. The other line, CHA(B)BIAS flips the polarity of the A/D bias voltage to match the chopping polarity. This line comes from U21.

CHA(B)MCHP	CHA(B)BIAS	CHOPPER POLARITY
0	1	Invert
1	0	Non-invert
0	1	Invert
1	0	Non-invert

Sensor Gain

The amplifier in the sensor has two gain settings. This is controlled by a line from U21 called CHA(B)SGN. The assignment is as follows:

CHA(B)SGN	Gain
0	1
1	8

Sensor Chopper Control

The chopper in the sensor is controlled by a line from U104 called CHA(B)SCHP. The assignment is as follows:

CHA(B)SCHP	Chopper Polarity
0	Non-invert
1	Invert

4.4 Calibrator Module

Sheets 4 and 5 of the A2 Circuit Schematic (drawing #30165) cover the interconnections for the Calibrator circuit. The Calibrator Module is located on the Analog PC Board. It is basically the heart of the 8540C Series Power Meters in that it is a patented system that allows the power sensors to be calibrated against an internal thermistor power standard (see Figure 4-3). In contrast to the conventional fixed-level calibrators, the 8540C calibrator produces a range of power levels over a 50 dB dynamic range to an accuracy of a few thousandths of a dB.

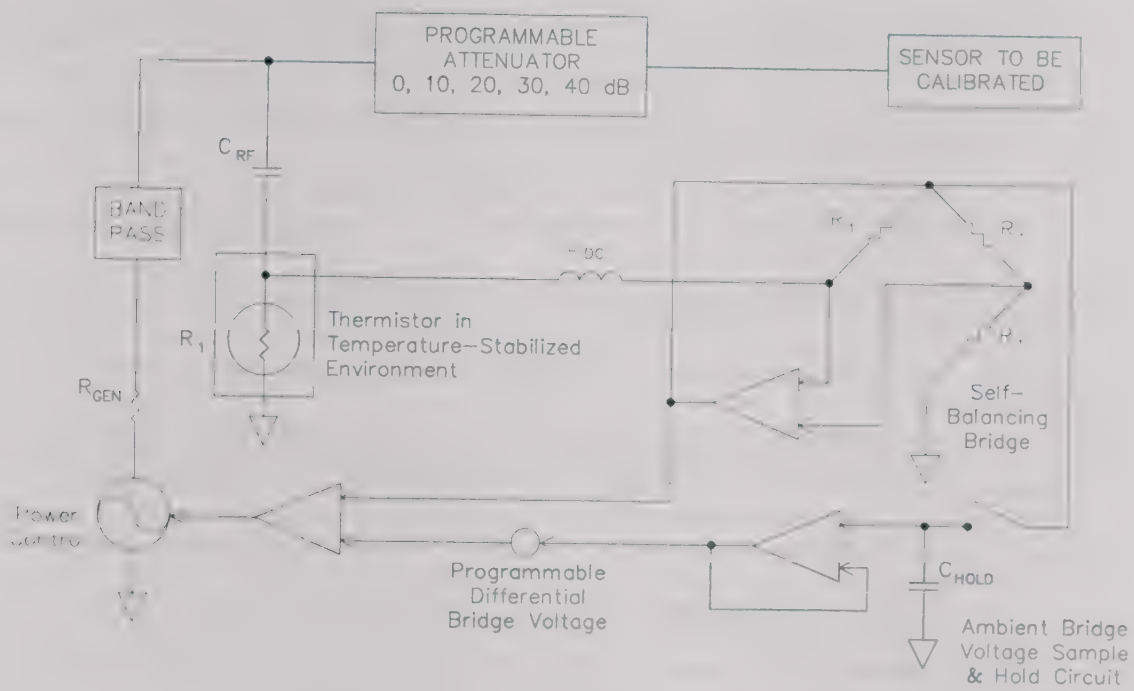

Figure 4-3. Calibrator Internal Power Standard

The thermistor is mounted in a self-balancing bridge configuration using dc substitution in the bridge. In this arrangement, the thermistor is maintained at a fixed operating point and the dc power in the thermistor, P_{DC}, is related to the RF power, P_{RF}, by the simple relationship:

$$P_{DC} + P_{RF} = P_{AMBIENT} = constant$$

The constant, $P_{AMBIENT}$, is found by turning the RF power off and measuring the ambient voltage, $V_{AMBIENT}$, to which the self-balancing bridge settles. The advantage of this approach is that the linearity of the thermistor-leveled oscillator is limited only by the accuracy with which dc voltages can be measured and the stability of the RF calibrator. To ensure exceptional stability, the thermistor assembly is enclosed in a temperature-stabilized environment and a low drift sampling circuit is used to hold the ambient bridge voltage. The RF power can then be programmed by controlling a difference voltage, δV, at the summing node. The power is related to the voltage by:

$$P_{RF} = \frac{V_{AMBIENT}\delta V - delta^2}{R_1} - \frac{delta^2}{2R_1}$$

This permits the RF power to be precisely controlled over a dynamic range of about 12 to 15 dB. The dynamic range is extended using a switched attenuator, the properties of which are determined using the thermistor-leveled oscillator itself. The effective attenuation (including all mismatch effects) of each attenuator relative to the next is measured by finding a pair of powers, one for each attenuator, that produces identical signals from the sensor under test. Because the sensor under test is used at a fixed operating point, no knowledge of its detection law is required.

4.4.1 General

The operation of the various circuitry functions of the Calibrator Module can be understood more easily if the circuits are discussed individually. The 11 functional sections of this module include the following:

1. The 50 MHz oscillator, Q4, and its current control circuit consisting of U16D, Q5, and U2C.
2. The RF output circuit consisting of the low pass filter, the stepped attenuator, and the connector and cable to the front panel of the 8540C meter.
3. The oven that maintains the control thermistor at a constant 60 °C is located on the small board attached to the bottom of the heater transistor, Q1. The board has two thermistors, RT1 and RT2, and Q7, the control transistor.
4. The thermistor bridge used to measure the RF power by dc substitution, consisting of RT1, U1, and Q6.
5. The track and hold circuit that remembers the ambient bridge voltage, using U2B, U8D, and U3A.
6. The 14-bit DAC and reference supply used to measure the ambient bridge voltage and control the RF output level, made up of U11, U7, U8A & B, U6, U16A, U13, U12, U4, and U15.
7. The correction circuit used to measure the temperature of the pin diode attenuator so that a correction for the temperature dependent loss of the diodes can be corrected, consisting of RT2 and U16C.
8. Sensor NV (Non-Volatile) RAM control circuit, U41D/E/F, Q3, and U18.
9. Calibrator NVRAM control circuit, U14 and U18.
10. Sensor interrupt control circuit, U9, U10A, U40A/B/C, and U39A.
11. The digital control circuit consisting of U18, U15B/C, U10B/C, U9B, and U15A.

4.4.2 50 MHz Oscillator

The first section of the Calibrator Module Assembly circuitry consists of a colpits oscillator circuit with a controllable power output. The output power is measured by the thermistor bridge and set by varying the dc current through Q4. This current is supplied by a voltage to current converter circuit consisting of U16D, Q5, and U4. The power generated by Q4 is nearly linearly related to the current through it. Thus, the voltage from U4 that is converted to current by U16D and Q5 is linearly related to the RF power generated. When the calibrator is set for 0 dBm, the voltage at U4-6 is near 0 volts.

4.4.3 RF Output

The 50 MHz oscillator output is capacity coupled to the low pass filter, L13, L14, L15, and associated capacitors. The resultant harmonic-free RF is applied to the switched pin attenuator, CR8 - 14, and associated resistors and control amplifiers U19 and U16B. The first section is 10 dB, the output section is 20 dB, and a resistor between sections adds another 10 dB. Thus, the output power can be programmed from +20 to -30 dBm.

4.4.4 Oven

The measuring thermistor is maintained at a constant 60 °C by being mounted on the heater transistor, Q1, which is driven from the sensing thermistor RT2 by way of the Q7 current amplifier. RT2 is mounted very close to RT1 so that both are maintained at the same temperature. When RT2 gets to a temperature of 60 °C, the voltage across it is just enough to maintain drive to the heater. This condition will be maintained regardless of the ambient temperature.

4.4.5 Thermistor Bridge

RT1 is connected in a self-balancing bridge circuit which will deliver just enough power to the thermistor to keep it at 500 ohms. Thus, if part of the power delivered to it is from the RF generated by the oscillator and the rest is from the dc current of the bridge, then by reducing the amount of dc power, the circuit will increase the drive to the oscillator as needed to keep the total power in RT1 constant. It is only necessary to measure the amount of dc power reduction to know the amount of RF power present. In this way, a precisely known RF output level can be established.

4.4.6 Track & Hold and DAC

In order to know how much power is being added by the oscillator, it is necessary to measure the power delivered to the thermistor with no RF present. This is done by turning off the oscillator power (closing switch U2C), and then measuring the voltage out of the control bridge. This is known as the ambient bridge voltage. To make this measurement, the following conditions are established: U8D and U2B are switched open, and U8A & C switch closed. Then, by using the DAC, U13, a successive approximation measurement of the voltage is made. Note that the output of the DAC is connected to one input of U4, and the bridge is connected to the other. Thus, it becomes a comparator that will make it possible for the computer to tell when the output voltage of the DAC is greater than the bridge voltage, and so complete the successive approximation. Once this is done, the DAC is set for 0V output, U8A is opened, U8B is closed, U8D and U2B are closed, and the track and hold capacitor, C39, will charge up to the voltage which represents the zero RF power condition of the bridge. When the oscillator is turned on by U9C, then the sampling switch, U2B, will open and allow C39 to supply this RF OFF condition to the measuring circuit. Any voltage from the DAC will now reduce the amount of dc power being delivered to the thermistor bridge, and the control circuit will add just enough current to the oscillator to cause its output to add back that much RF power into the bridge.

4.4.7 Correction Thermistor Circuit

The compensation thermistor is mounted near CR13 to sense the temperature of the 20 dB attenuator section that is used to produce the 0 dBm output. This is the only absolute power specified. All other power levels are measured by the software relative to 0 dBm.

4.4.8 Calibrator NVRAM Control Circuit

The calibrator serial number and the correction constant for the 0 dBm output level, as well as the date of calibration and password for rewrite access, is contained in a Non-Volatile RAM. The read and write for it is provided by the parallel peripheral interface (PPI) U18. Before allowing access to the NVRAM, the software looks for a logic 1 on port A, bit 0 of the PPI and, if that is present, it asks the operator for the password. If the correct password is supplied, then the collected data will be written into U14. If the jumper W1 is set to supply a logic 0 to the PPI, the operator will then have write access to U14 without needing a password.

4.4.9 Sensor NVRAM

Each sensor has a NVRAM which is used to store all of the calibration constants, the date of calibration, place of calibration, etc. This NVRAM is also password protected, but has no hardware switch to defeat it. The read/write control for it is furnished by U41A/B/C, U41D/E/F, Q2, and Q3 which control the 5 V supply in order to reduce the amount of heat in the sensor, as well as reducing the noise from the supply.

4.4.10 Sensor Interrupt

Each time a sensor is connected or disconnected from the 8540C, a CPU interrupt is generated by causing the thermistor voltage change to set a latch which signals the CPU that it needs to check for a sensor change. The latch is driven from a window comparator, U39D and U40A & B. This comparator is driven from capacitors which are connected to each of the thermistor lines from the sensors. The latch is enabled or cleared by a signal from the PPI, U18.

4.4.11 Digital Control Circuit

The digital control circuit is the interface between the CPU and the preceding functions.

4.5 Front Panel PC Assembly (A3)

(Refer to the A3 Front Panel Circuit Schematic on page 8-21.)

The Front Panel PC assembly consists of a 4 X 4 keyboard matrix and circuitry to interface the 20 front panel LEDs to the CPU board (see Figure 4-4). The LCD Display (A4) is an OEM purchased part and does not include a circuit schematic in this manual.

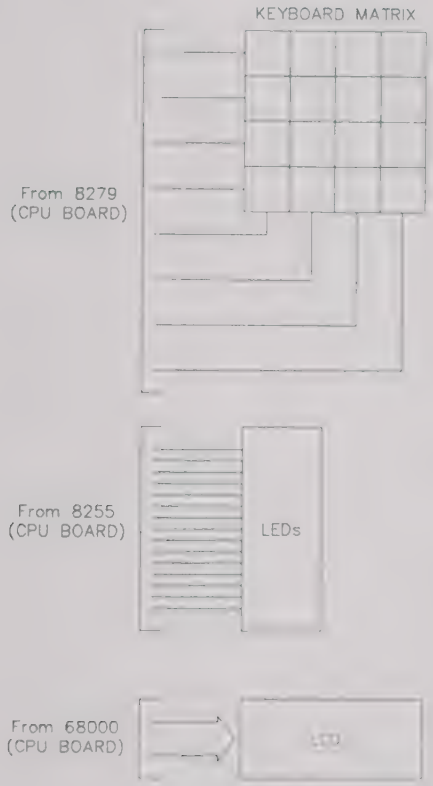

Figure 4-4. Front Panel PC Assembly

5

Calibration & Testing

5.1 Introduction

This chapter includes procedures for calibration and performance testing the Series 8540C Universal Power Meters.

Refer to Appendix B of this manual for power sensor selection and calibration.

5.2 Calibration Procedure

If any of the instrument performance characteristics cannot be calibrated within specification, refer to the troubleshooting procedure in Chapter 6.

5.2.1 Equipment Required

Table 5-1 lists the equipment required for calibration of the 8540C power meters.

Table 5-1. Equipment Required for Calibration

Description	Representative Model	Key Characteristics
CW Thermistor Power Meter	HP 432A	V_{RF} and V_{COMP} available externally
Thermistor Mount	HP 478A-H75	≤1.07 VSWR @ 50 MHz (30 dB return loss) Accuracy ±0.5% @ 50 MHz
Digital Voltmeter (DVM)	Fluke 8842A	±0.05% accuracy & 1 µV resolution
Directional Coupler, 10 dB	Mini Circuits ZFDC-10-1 10 dB	≤1.15 SWR @ 50 MHz
Step Attenuator, 0 to 90 dB in 10 dB increments	Weinschel Model AC 118A-90-33	≤1.15 SWR @ 50 MHz ±0.1 dB attenuation
RF Source (Signal Generator) (High Power)	Wavetek Model 2405 Option XP	+22 dBm @ 50 MHz
Low Pass Filter	Integrated Microwave Model 904 881	>30 dB attenuation @ 100 MHz
GPIB Controller for IBM PC	National PC2/2A	With driver software

5.2.2 Calibrator Output Power

Perform the Calibrator Output Power Reference Level check (see Section 5.3.2). If the unit fails to meet the power output specification within the 0.981 mW to 1.019 mW minimum and maximum limits, then proceed with the steps below.

To correct the setting of the power output of the calibrator, you must know the password if it has been set, or you must defeat it by setting jumper A2W1 to position B. (This jumper is located and indicated on the Analog PC Board.) If no password has been set, you can proceed with the jumper in position A. Calculate the percent error in power (as described in the Performance Verification Level check) and change the CALFAC by that amount. For example, if the power output is low by 0.5% then increase the CALFAC by that amount. In the following procedure if you make a mistake and wish to start over, press [ESCAPE] and then continue from Step 1.

1. Press [MENU].
2. Scroll to **SERVICE MENU** (using one of the up/down, left/right keys on the front panel) and press [ENTER].
3. Scroll to **CALIBRATOR** and press [ENTER].
4. Select EEPROM and press [ENTER].
5. Press [ENTER] to get past **SNumb** (unit serial number).
6. Enter CALFAC change using the number obtained at the beginning of this test. Press [ENTER].
7. Correct the date and press [ENTER].
8. Correct the time and press [ENTER].
9. Select **WRITE** and press [ENTER].
10. Enter the correct password if needed. If it is not needed, you can either set one or clear it. Press [ENTER].
11. You must verify that the correction has been done by again entering (reads new Cal Fac number):
    a. Scroll to the **SERVICE MENU**.
    b. Scroll to **CALIBRATOR** and press [ENTER].
    c. Select **Power** and press [ENTER].
    d. Select **0 dBm** and press [ENTER].
12. If the calibrator is now within tolerance, perform step 11 again and turn the calibrator **OFF** instead of selecting 0 dBm.

The sensor(s) can now be calibrated by connecting to the calibrator output and pressing ZERO/CAL. If the calibration does not complete satisfactorily, refer to the calibrator voltage and frequency checks starting on page 5-3.

The Linearity test can now be performed as detailed in Section 5.3.3. This is a complete procedure, and must be performed in the exact order given to produce accurate results. If this test fails, try it again with a different sensor. If it still fails, refer to the calibrator voltage and frequency checks starting on page 5-3.

The following tests require that the power meter's housing be removed. To remove the cover, remove the three Binder head screws on the back panel and slip the cover off. This can best be done by carefully resting the unit on the front panel using a cushion or pad to prevent scratching.

Refer to the Analog PC Board description in Chapter 4 for further help in defining the problem. If the fault cannot be located to the component level, the PC board can be removed and replaced with a different one with no further calibration required except to set the calibrator output power to 0 dBm.

5.2.3 Power Supply Voltage Checks

There are a number of power supplies in the power meter. The rectifiers, filters, and regulators for the ±15 volt and the +5 volt supplies are on the CPU PC Board (A1). All the other supplies are on the Analog PC Board (A2). In case there is a regulated voltage failure, check the corresponding unregulated supply (see Sheet 3 of the A1 Circuit Schematic on page 8-8). The unregulated voltage must be at least 2 volts more than the required regulated output.

To measure the supplies, turn the unit on and let it stabilize for a minute or so. Then proceed as follows:

1. Connect the low side of the DVM to A2TP3 (GND)
2. Connect the high side to the points shown in Table 5-2.

Table 5-2. DC Power Supply Test Points

Test Point	Voltage
A2TP3	GND
TP4	-14.25 to -15.75
TP5	4.8 to 5.2
TP2	14.25 to 15.75
U33-3	11.4 to 12.6
U40-3	-11.4 to -12.6
TP37	4.8 to 5.2
U83-3 (Ch. B)	-4.8 to -5.2
U82-3 (Ch. B)	4.8 to 5.2
U57-3	-4.8 to -5.2
U58-3	4.8 to 5.2
TP27	11.4 to 12.6
TP29 (Ch. B)	11.4 to 12.6
TP30 (Ch. B)	-11.4 to -12.6
TP28	-11.4 to -12.6
U16-1	-9.1 to -10.9

5.2.4 Calibrator Voltages

To measure the calibrator voltages, first make sure that neither side of the DVM is grounded. The following measurements should find most of the problems that can arise in the calibrator circuitry.

1. Connect the DVM across the large resistor, A2R174. Measure 0.4 to 0.9 volts depending on the room temperature and how long the unit has been operating. This voltage is proportional to the current in the thermistor heater transistor which maintains the calibrator thermistor in a 60 °C environment. The voltage measured in the next step is dependent on this being correct.

   The exact ambient temperature and on-time of the instrument mentioned in Step 1 are not specific factors, but do have some effect on the reading taken across A2R174. If there is a problem in the circuit, the measured voltage will usually be outside of the 0.4 to 0.9 Volts specification (for example, 0 Volts or +5 Volts).

2. Connect the low side of the DVM to A2TP3 and the high side to A2TP1. Measure +7 to +8.5 volts. This is the voltage applied to the thermistor bridge that is used to measure the calibrator power. This voltage will vary as the calibrator provides different amounts of RF power.

This measurement assumes that the calibrator is OFF. To verify that the calibrator is off, press MENU, scroll to REF POWER ON/OFF, press ENTER select OFF, and press ENTER again.

3. Turn the calibrator ON. Press MENU, scroll to REF POWER ON/OFF, press ENTER, select ON, and press ENTER. Now connect the high side of the DVM to A2U3, pin 7. Measure +3 to +10 volts which should change less than 2 mV per minute. Turn the calibrator off. If the voltage is incorrect or drifts excessively, troubleshoot the sample and hold circuit surrounding A2U3A.

5.2.5 Calibrator Frequency Check

To measure the frequency of the calibrator:

1. Connect a 50 MHz counter to the calibrator output connector.
2. Turn ON the calibrator according to the procedure given in Step 3, above.
3. Measure 49 to 51 MHz.
4. Turn the calibrator OFF.

5.2.6 GPIB Test Functions

If the unit will not calibrate its sensors, there are some test functions available through the GPIB. Using these functions, it is possible to check out the operation of the different parts of the calibrator system.

1. Connect a controller to the GPIB interface connector on the rear panel of the unit, and set the address as required.
   a. Press MENU. Scroll to the Config menu and press ENTER.
   b. Scroll to GPIB and press ENTER.
   c. Select the MODE and ADDRESS as needed and press ENTER. (MODE is either 8541C or 8542C. The default address is 13).
2. If the calibrator output power as measured in the Performance Verification Test is within tolerance but the unit will still not complete a sensor calibration, perform the following test to determine if the calibrator is operating correctly:
   a. Send TEST CALIB SOURCE 10 from the controller, followed by TEST CALIB ATTEN 0. The calibrator output should be +20 dBm ±0.8 dB.
   b. Send TEST CALIB ATTEN 10
   This will insert the 10 dB attenuator into the calibrator output. The power should measure a decrease of 10 dB ±1 dB.
   c. Repeat Step 2b, substituting 20, 30, and 40 successively in the command.
   The power should be attenuated by the attenuation level specified in the command ±1 dB. This will verify the health of all of the attenuators.
3. The next step is to verify the oscillator power control circuits. This is done by setting the power to higher and lower levels and measuring the results.

   Send the command TEST CALIB ATTEN 0, followed by TEST CALIB SOURCE X where X is -3 to +13. The resulting power output should range between -13 dB from the first reading taken in Step 2.a to at least +21 dBm.

This checks the calibrator control circuits completely. If the unit still will not calibrate a sensor the problem is in the measurement circuits, not the calibrator. Proceed to the next heading.

5.3 Performance Verification Tests

Information in this section is useful for periodic evaluation of the 8540C and its power sensors. These tests can also be used for incoming inspection testing when the instrument is first received, if required.

If the 8540C has not previously been used, review the precautions in Section 1.2 of the manual before the instrument is turned on. Prior to starting the following procedures, the instrument should be allowed to warm up for at least 24 hours to assure maximum stability during testing.

The test for the Calibrator Output Power Reference Level given in this section is valid for an ambient temperature range between +5 °C and +35 °C (+41 °F to +95 °F).

The instrument plus power sensor linearity test is valid when the sensor has been calibrated using the front panel calibrator at a temperature between 0 °C and +50 °C (+32 °F to +122 °F), and if operating within ±5 °C (±9 °F) of that calibration temperature.

It is recommended that the verification be done in the order described since some of the steps use the configuration from a previous step.

5.3.1 Equipment Required

Table 5-3 lists the equipment required for performance testing of the 8540C power meters.

Table 5-3. Equipment Required for Performance Testing

Description	Representative Model	Key Characteristics
CW Thermistor Power Meter	HP 432A	V_{RF} and V_{COMP} available externally
Thermistor Mount	HP 478A-H75	≤1.07 VSWR @ 50 MHz (30 dB return loss) Accuracy ±0.5% @ 50 MHz
Digital Voltmeter (DVM)	Fluke 8842A	±0.05% accuracy and 1 µV resolution
Directional Coupler, 10 dB	Mini Circuits ZFDC-10-1 10 dB	≤1.15 SWR @ 50 MHz
Step Attenuator, 0 to 90 dB in 10 dB increments	Weinschel Model AC 118A-90-33	≤1.15 SWR @ 50 MHz ±0.1 dB attenuation
RF Source (Signal Generator) (High Power)	Wavetek Model 2405 Option XP	+22 dBm @ 50 MHz
Low Pass Filter	Integrated Microwave Model 904 881	>30 dB attenuation @ 100 MHz
GPIB Controller for IBM PC	National PC2/2A	With driver software

Performance Verification Test Data Recording sheets are located on pages 5-11 and 5-12. These sheets can be copied and the copies used for recording test results each time Specification and Performance Verification testing is performed on the specific instrument described by this manual.

5.3.2 Calibrator Output Power Reference Level

The Calibrator Output power reference is factory adjusted to 1 mW ±0.7%. To achieve this accuracy, Giga-tronics uses a precision measurement system with accuracy to ±0.5% (traceable to the NIST - formerly the NBS), and allows for a transfer error of ±0.2% for a total of ±0.7%. If an equivalent measurement system is used for verification, the power reference oscillator output can be verified to 1mW ±1.9% (±1.2% accuracy, ±0.5% verification system error, ±0.2% transfer error, for a maximum error of ±1.9%). To ensure maximum accuracy in verifying the Calibrator Output power reference, the following procedure provides step-by-step instructions for using specified test instruments of known capability. If equivalent test instruments are substituted, refer to the Key Characteristics section in Table 5-3.

The test setup is illustrated in Figure 5-1.

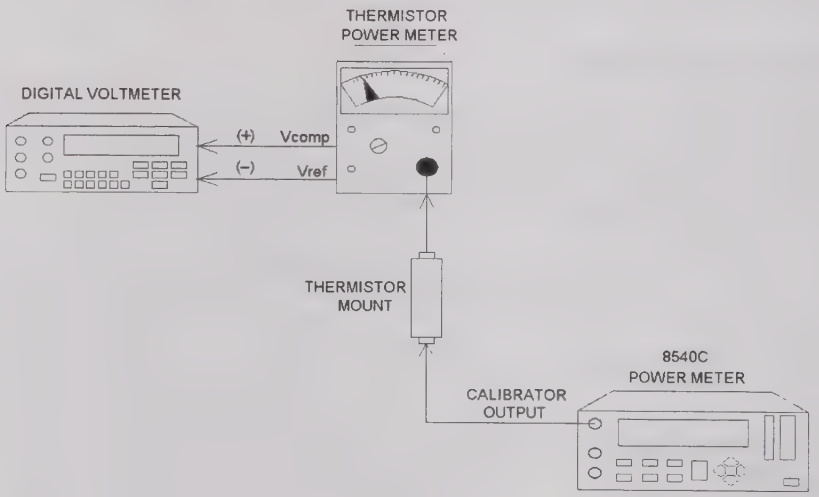

Figure 5-1. Calibrator Output Test Setup

Procedure:

In the following steps, precision power measurements will be made using the 432A Power Meter. For detailed information on using the 432A, please refer to the operating section of the 432A manual.

1. Connect the 432A to the Calibrator Output on the 8540C as shown in Figure 5-1.
2. Turn on all equipment and then wait 30 minutes for the thermistor mount to stabilize before proceeding to the next step.
3. Set the 432A RANGE switch to COARSE ZERO, and adjust the front panel COARSE ZERO control to obtain a zero (±2% F.S.) meter indication.

NOTE: Ensure that the DVM input leads are isolated from chassis ground when performing the next step.

---

4. Set the DVM to a range that results in a resolution of 1 μV and connect the positive and negative input, respectively, to the V_{COMP} and V_{RF} connectors on the rear panel of the 432A.
5. Fine zero the 432A on the most sensitive range, then set the 432A range switch to 1 mW.
6. Record the DVM indication as V_0.
7. Turn ON the 8540C Calibrator RF power as follows:

   Press MENU, scroll to REF POWER ON/OFF, press ENTER, select ON, press ENTER. Record the reading shown on the DVM as V_1.

   ☛ **NOTE**: The V_1 reading must be taken within 15 seconds after pressing ENTER. Otherwise, turn REF POWER OFF and repeat Steps 6 and 7.

8. Disconnect the DVM negative lead from the V_{RF} connector on the 432A, and reconnect it to the 432A chassis ground. Record the new indication observed on the DVM as V_{COMP}.
9. Repeat Step 7, except select OFF to turn the Calibrator off.
10. Calculate the Calibrator Output level (P_{CAL}) using the following formula:

$$P_{CAL}\,(Watts) = \frac{2V_{COMP}\,(V_1 - V_0) + V_0{}^2 - V_1{}^2}{4R(Calibration\ \ Factor)}$$

    where:

    P_{CAL} = calibrator output power reference level
    V_{COMP} = previously recorded value in Step 8
    V_1 = previously recorded value in Step 7
    V_0 = previously recorded value in Step 6
    R = 200Ω (assuming HP478A-H75 mount)

    Calibration factor = value for the thermistor mount at 50 MHz (traceable to the NIST)

11. Verify that the P_{CAL} is within the following limits:

    1 mW ±0.019 mW (0.981 to 1.019 mW)

    For record purposes, the measured value of P_{CAL} can be entered on the Test Data Recording Sheet located on page 5-11.

5.3.3 Instrument Plus Power Sensor Linearity

Test Description

Connect the test setup as shown in Figure 5-2. The linearity will be tested over the range +20 dBm to -60 dBm. At low power levels, the linearity measurement will include the uncertainty due to the zero set specification. The procedure should be repeated for each sensor used with the 8540C.

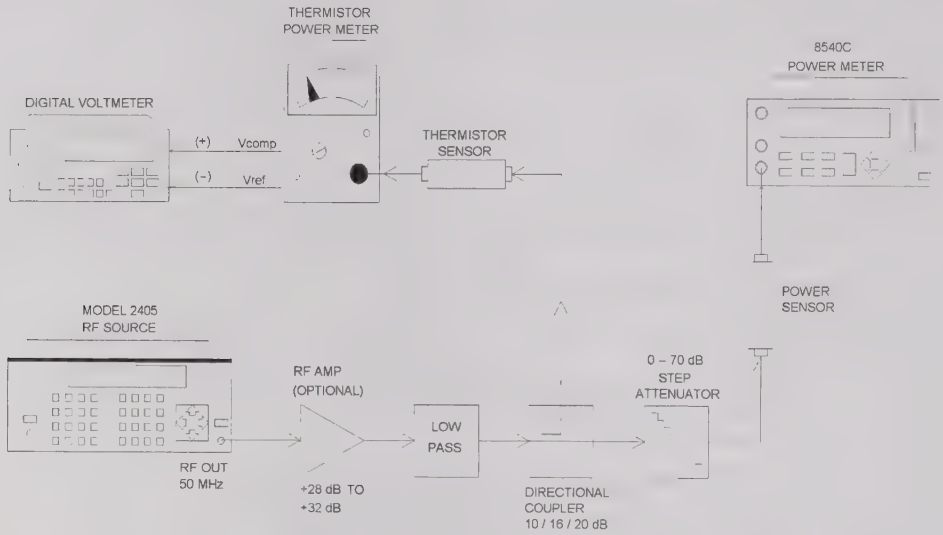

Figure 5-2. Power Linearity Test Setup

When measuring the linearity of a Low VSWR (Series 8031X) or a High Power (Series 8032X) sensor, the power output of the source must be increased by 6 or 10 dB respectively and the directional coupler must be increased from 10 dB to either 16 or 20 dB respectively (see Figure 5-2). The power coefficient of the step attenuator will also have to be considered. The specification of power coefficient for the Weinschel attenuator cited in the Equipment List is: <0.005 dB/dB/W. The latter will affect the linearity of each 10 dB segment, and make it necessary to expand the overall linearity specification by this quantity.

In assembling the test setup shown in Figure 5-2, keep in mind that if testing is to be conducted with Low VSWR or High Power sensors, the optional RF Amplifier must have frequency and bandwidth parameters to match the sensor's characteristics (see the Sensor Selection Guide in Chapter 1, if unsure of characteristics), and the Directional Coupler must be increased as stated above for the particular series of sensors. All Standard (Series 8030X) and True RMS (Series 8033X) sensors are tested with a 10 dB Directional Coupler and without the optional RF amplifier.

Refer to the Linearity Data recording section of the Performance Verification Data recording sheets located on pages 5-11 and 5-12. The tolerance is already entered for the various steps, and includes an allowance for specified zero set errors at low power levels.

☛ **NOTE**: To ensure accurate and repeatable measurements, the 432A power meter should be zeroed just before taking each reading that will be used to calculate P1 in the Power Meter column of the Performance Verification Test Data Sheets on pages 5-11 and 5-12.

Setup Parameters

The following setup parameters should be accomplished prior to performing the Power Linearity test:

1. The 8540C and sensor should be calibrated (see Section 2.6.3. Refer also to the complete instructions on how to calibrate the sensor in Appendix B of this manual).
2. The Averaging is set to AUTO by entering the key sequence
   [MENU] [Meas Setup] [Average] [Avg A] or [Avg B] [Auto]

Test Procedure

Extreme care is required in the following procedure since the accuracy requirements are critical to ensure the most accurate test results.

Power readings are determined using the thermistor power meter in the same general way as given in the Power Reference Level test. That is, P1 and P2 in the Power Meter reading column of the Performance Verification Test Data Sheet tables are calculated each time for the respective values of V_{COMP}, V_0, and V_1 read on the DVM.

1. Set the step attenuator to 70 dB. Turn the source power output off, and then zero the 8540C.

   (The 8540C is zeroed by pressing [ZERO/CAL] and then following the softkey label instructions.)
2. Set the step attenuator to 0 dB after the 8540C has zeroed.
3. Set the power output of the RF source so that the thermistor power meter indicates 1.00 mW ±0.025 mV.
4. Record the calculated power meter reading and the displayed 8540C reading in the correct columns of the Linearity Data recording sheet on page 5-11.
5. Set the power output of the RF source so that the thermistor power meter indicates 3.98 mW ±0.10 mW.
6. Record the new calculated power meter reading and the new displayed 8540C reading as in Step 4 above.
7. Set the power output of the RF Source so that the thermistor power meter indicates 3.98 mW ±0.10 mW.
8. Record the calculated power meter reading and the displayed 8540C reading as in Step 4, above.
9. Set the power output of the RF Source so that the thermistor power meter indicates 5.01 mW ±0.13 mW.
10. Record the new calculated power meter reading and the new displayed 8540C reading as in Step 4, above.
11. Repeat using the power meter indications in the Data Recording sheet on page 5-12. Note that the Step Attenuator is used to generate the remaining 70 dB range of 10 dB steps for a total range of 80 dB. Repeat Step 1, above, between each 10 dB step shown on the Linearity Data Recording sheet.
12. Make the calculations indicated on the Linearity Data sheet, and enter the values in the appropriate blank spaces.

5.3.4 GPIB Port Check

The following steps are used to confirm that the GPIB port is functional.

1. Set the 8540C to the desired address (the default is 13; see Table 2-1 for address setting instructions if necessary.)
2. Connect the GPIB controller to the GPIB Port on the rear of the 8540C.
3. Send the command (if emulating an HP 438):

   *IDN? or ?ID

   (*IDN? is the IEEE 488.2 Common ID query. When addressed to talk after receiving the command, the 8540C will output a string that identifies itself as Model 8541C or 8542C.)
4. Display the response on the controller.

This completes the Specification and Performance Verification Tests for the 8540C Series Digital Power Meter and its sensors. If the instrument has performed as described in this chapter, it is correctly calibrated and within specifications.

GIGA-TRONICS 8540C SERIES PERFORMANCE VERIFICATION TEST DATA SHEET

Date:	
Operator:	
Test Number:	(if required)
Series 8540C S/N:	
Power Sensor S/N:	

Calibrator Output Power Reference

Minimum	Actual Reading	Maximum
0.981 mW		1.019 mW

Linearity Data - (+16 dBm to +20 dBm)

Step Attenuator Value	Power Set Point	Power Meter Reading (P)	8540C (DUT) Reading (R)	Reference Power Ratio	8540C (DUT) Reading Ratio	Linearity Error (%)[1]	
						Linearity Specification	Accumulated Linearity Error[2]
0 dB	1.00 mW ±0.025 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	3.98 mW ±0.10 mW	P2 =	R2 =			±1%	Same as Lin. error above
0 dB	3.98 mW ±0.10 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	5.01 mW ±0.13 mW	P2 =	R2 =			+1% -1.6%	
0 dB	5.01 mW ±0.13 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	6.31 mW ±0.16 mW	P2 =	R2 =			+1% -2.7%	
0 dB	6.31 mW ±0.16 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	7.94 mW ±0.2 mW	P2 =	R2 =			+1% -3.8%	
0 dB	7.94 mW ±0.2 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	10 mW ±0.25 mW	P2 =	R2 =			+1% -4.9%	

(continued)

-60 dBm to +16 dBm Linearity Data are on the next page.

Notes:

1. Linearity Error (%) = [(R1/R2) / (P1/P2) - 1] x 100
2. Accumulated error is the sum of the current dB segment linearity error plus the previous accumulated error.

Linearity Data - (-60 dBm to +16 dBm)							
Step Attenuator Value	Power Set Point	Power Meter Reading (P)	8540C (DUT) Reading (R)	Reference Power Ratio	8540C (DUT) Reading Ratio	Linearity Error (%)[1]	
						Linearity Specification	Accumulated Linearity Error[2]
0 dB						See Note 3	
						±1%	Same as Lin. error above
10 dB	1.00 mW ±0.025 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	10.00 mW ±0.25 mW	P2 =	R2 =			±1%	
20 dB	1.00 mW ±0.025 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	10.00 mW ±0.25 mW	P2 =	R2 =			±1%	
30 dB	1.00 mW ±0.025 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	10.00 mW ±0.25 mW	P2 =	R2 =			±1%	
40 dB	1.00 mW ±0.025 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	10.00 mW ±0.25 mW	P2 =	R2 =			±1%	
50 dB	1.00 mW ±0.025 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	10.00 mW ±0.25 mW	P2 =	R2 =			±1%	
60 dB	1.00 mW ±0.025 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	10.00 mW ±0.25 mW	P2 =	R2 =			±1.5%	
70 dB	1.00 mW ±0.025 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	10.00 mW ±0.25 mW	P2 =	R2 =			±6%	

Notes:

1. Linearity Error (%) = [(R1/R2) / (P1/P2) - 1] x 100
2. Accumulated error is the sum of the current dB segment linearity error plus the previous accumulated error.
3. Use the first CW Linearity error value entered in the +16 dBm to +20 dBm Linearity Data on page 5-11.

6 Maintenance

6.1 Periodic Maintenance

This chapter describes maintenance practices, and troubleshooting guidelines for the 8540C.

6.1.1 Testing & Calibration

The 8540C should be periodically tested (and calibrated, if it will not pass all performance tests), using the test and calibration procedures described in Chapter 5 of the manual.

Testing (and, if necessary, calibration) should be performed at one year intervals, unless the 8540C is operated in an extremely dirty or chemically contaminated environment, or is subject to severe abuse (such as being dropped). In such cases, more frequent maintenance (immediate, if the unit is dropped or severely abused in some way) is required.

6.1.2 Cleaning

The front panel and housing of the unit can be cleaned using a cloth dampened in a mild detergent. Do not use abrasive cleaners, scouring powders, or any harsh chemicals. Wipe the soap residue off with a clean, damp cloth, then dry with a clean dry cloth.

6.1.3 Lithium Battery

The power meter contains a 3.6V lithium battery, which preserves configuration and calibration data while line power is off.

If the 8540C is to be placed in long term storage (2 years or more), the battery should be removed.

To check the battery, connect a voltmeter between TP13 (ground) and TP16 (+) on the CPU PC Board (A1). If the voltage is less than 3.1V, the battery should be replaced.

Replacement

Battery life depends on the usage of the 8540C. With normal daily use, the battery is expected to last at least three years. To avoid unintentional loss of data in the volatile memory of the 8540C, it is recommended that the lithium battery be replaced every three years. This can be done without losing the data stored in RAM if the old battery is removed and the new battery installed in less than 10 seconds with main power off, or if power is left on while changing the batteries.

WARNING

Battery replacement requires removing the cover from the instrument and then restoring power before removing the battery. This procedure should be performed only by qualified personnel.

This replacement procedure is intended for users knowledgeable in the use and care of equipment using non-rechargeable lithium batteries. The recommended replacement battery is a Tadiran Type TL-5242, Giga-tronics Part# 21212.

Lithium batteries can supply substantial current and, depending on factors such as the state of charge, can overheat when shorted.

1. Turn OFF the 8540C.
2. Remove the cover.
3. Turn ON the 8540C (to maintain memory power while replacing the battery).
4. Note the orientation of the battery which is located on the left side of the top (CPU) PC board, half way back in the unit. The battery is held in place with a plastic clamp and a "hook and loop" fastener. Cut the plastic clamp and peel the battery free of the PC board.
5. Disconnect the battery wires. The connector is polarized so it can only be inserted one way, with the red wire toward the rear of the instrument.
6. Install the new battery, replace the plastic clamp, and connect the wires.
7. Turn OFF the 8540C and measure the battery voltage between TP13 (com) and TP17 (bat). It must be at least 3.5V.
8. Replace the cover and secure.
9. If desired, a label can be attached indicating when the next battery replacement is due.

To test for satisfactory operation of the new battery, turn the 8540C ON, calibrate a sensor, turn the 8540C OFF, wait ten seconds, and turn the 8540C instrument back ON. The sensor calibration should still be valid, as indicated by the displayed power level.

6.2 Troubleshooting

If the 8540C seems to be malfunctioning, the first step is to determine whether or not the problem is actually being caused by the 8540C. Investigate any auxiliary equipment to which the 8540C is connected, and check all connections between devices in the test setup. Make sure that the 8540C has not been configured incorrectly (either by way of the front panel configuration menus or over the GPIB).

Before investigating the 8540C's circuits, review the circuit descriptions in Chapter 4.

☛ **NOTE:** If you are returning an instrument to Giga-tronics for service, first contact Giga-tronics customer service at (800) 444-2878 or Fax (510) 328-4702, so that a return authorization number can be assigned.

6.2.1 General Failure

If the front panel displays are erratic, blank, or unresponsive to the front panel controls, this suggests a general breakdown of the control system, probably resulting from a problem in the power supply or the CPU circuit.

1. If nothing will light up on the front panel at all (not even the backlighting of the display window), check the fuse. If the fuse has failed, check the line voltage setting, correct it if it is wrong, and replace the fuse (see Section 1.2). The display window may not show a readable message if the contrast setting on the rear panel is not adjusted properly.
2. Investigate the power supply circuit (see Sheet 3 of the A1 Circuit Schematic, drawing #21694 in Chapter 8); check all regulated voltage outputs.
3. Check the connections between the CPU PC board (A1), the LCD display PC board (A4) and the Front Panel PC board (A3).

6.2.2 Channel-specific Failure in the 8542C

If the instrument is a Model 8542C and only one of the two sensors will calibrate, troubleshoot the circuits associated with the channel that fails. The separate channels are shown on Sheet 1 (Ch A) and Sheet 2 (Ch B) of the A2 Analog Circuit Schematic, drawing #21697 in Chapter 8. For example, if the unit will calibrate sensor A but not sensor B, proceed as follows:

1. Try reversing the two sensors to determine if one of them is bad.
2. If the unit fails to display the **B UNCALIBRATED** message, or fails to display any sensor B data when the sensor is connected, the problem probably lies in the temperature sensing thermistor circuit which connects to U39, pin 3. Measure the voltage at U39, pin 1. It should be about 2 or 3 volts. If it is above 7 or below 0.5 volts, the thermistor circuit is faulty.

6.2.3 Functional Failures

If the power supplies and the CPU seem to be working normally, yet the 8540C will not perform its calibration or measurement functions, it is necessary to perform more detailed testing to find the source of the problem. A number of instrument self-test functions are available. On the Service menu, select TEST FUNCTIONS for an extensive menu of tests.

7

Parts Lists

7.1 Introduction

This chapter contains the parts lists for all major and minor assemblies in the Series 8540C Universal Power Meters. Parts lists for available Options are in Appendix C under the respective option heading . A list of Manufacturers is included in Section 7.3.

7.2 Parts Lists for Series 8540C Universal Power Meters

If not otherwise specified, the following parts lists apply to both the Model 8541C and 8542C power meters.

8541C SINGLE CHANNEL POWER METER, Rev: C

Item	Part Number	Qty	Cage	Mfr's Part Number	Description
1	30160	1	58900	30160	8541C CHASSIS ASSY
2	30280	1	58900	30280	SERIES 8540C OPER/MAINT MANUAL
3	WMP0-03007	1	16428	17250	7.5' IEC POWER CORD
4	20954-001	1	54516	20954-001	DET EXT CABLE ASSY 1.5M (5 FT)
5	30614	1	58900	30614	STANDARD COVER
6	21205	2	62559	10603-023	TIP-UP FOOT
7	21206	2	62559	10603-024	GRAY FOOT
8	21301	2	58900	21301	SIDE TRIM, 8540
9	21118	1	58900	21118	LABEL, TESTED BY
10	21324	22	58900	21324	GROUND STRIP
11	HBPP-44004	3	26233	NS137CR440R4	4-40 X 1/4 PAN
12	HBPP-44006	4	26233	NS137CR440R6	4-40 X 3/8 PAN
13	30016	REF	58900	30016	8540 SYSTEM TEST PROCED

30160 8541C CHASSIS ASSY, Rev: H

Item	Part Number	Qty	Cage	Mfr's Part Number	Description
1	30157	1	58900	30157	FRONT DEC. PANEL 8541C FAB
2	21200	1	58900	21200	CHASSIS
3	30506	1	0JBU8	30506	854X TOROIDAL PWR XFMR
4	21215	1	05245	6EDL4C	AC INPUT MODULE
5	20070	1	58900	20070	250VAC PUSHBUTTON SWITCH
6	30161	REF	58900	30161	8540C SERIES SCHEMATIC
7	10129	1	58900	10129	LABEL, CODE AND SERIAL NUMBER
8	30508	1	58900	30508	854XC XFMR SPACER
10	13700	1	31918	FSC-BLACK	BLACK BUTTON
11	JMPF-00003	6	09769	60617-1	FEMALE PIN
12	14931-003	1	09769	1-480270-0	6 POSITION SKT HOUSING
13	30449	1	58900	30449	HIGH VOLTAGE LABEL
14	30438	1	58900	30438	PROM SET,MODEL 854XC
15	21322	4	0HFJ2	27SR0018	NYLON SNAP RIVET
16	21323	1	13103	21323	SILICONE INSULATOR
17	30013	REF	58900	30013	8540 SERIES JIT FLOW CHART
18	30552	REF	58900	30552	8540C PRETEST PROCEDURE
19	HT00-00409	3	53421	T-18R	4 WHITE CABLE TIE
20	10495-019	1	92194	FIT-221-1 CLEAR	1" CLEAR SHRINK TUBING
21	30553	REF	58900	30553	8540C CALIB PROCEDURE
22	30017	REF	58900	30017	8540 CABINETIZING PROC
23	12936	1	16428	8723	CABLE SHIELD 4 COND
24	10469-005	0	51705	SLV-130-20	20 GA 'GLASS' SLEEVING
25	WKAC-18708	2	92194	FIT221-1/8 X 1	3/16 X 1/2 SHRINK TUB
26	10131-002	0	92194	297	WIRE BUS BAR 20 GA
27	10495-014	0	92194	FIT-221-1/8-BLACK	1/8" BLACK SHRINK TUBING
28	11438	2	——	SP5303-GRAY	MOLDED BUMPER
101	HBFP-63205	2	58900	HBFP-63205	6-32 X 5/16 FLAT
102	HNSS-63205	2	58900	HNSS-63205	6-32 HEX NUT
103	HBPP-63204	4	58900	HBPP-63204	6-32 X 1/4 PAN
104	10116-004	2	58900	10116-004	SCR, PNH PHILLIPS 2-56x.125
105	JMSF-00003	1	09769	552633-3	IEEE CONN MOUNTING
106	HBFP-83240	1	58900	HBFP-83240	8-32 X 2.5 FLAT
107	HNNS-83205	1	96906	M517828***	8-32 LOCKING NUT
108	10148-002	2	2R182	1415-6	SOLDER LUG, 30 DEG LOCKING #6
A1	21693	1	58900	21693	CPU PCB ASSY 854xB
A2	30164	1	58900	30164	8541C ANALOG P.C. ASSY
A5	21331	1	58900	21331	FRONT PANEL ASSY, 8541
F1	FSAC-00075	1	——	MDL-3/4	.75A SB FUSE 3AG
RT1	20033	1	58900	20033	275 V METAL OXIDE VAR.
W3	21175-002	1	58900	21175-002	CABLE ASSY,CPU-GPIB

21331 FRONT PANEL ASSY, 8541, Rev: A

Item	Part Number	Qty	Cage	Mfr's Part Number	Description
1	21153	1	58900	21153	KEY PAD
3	21655	1	——	21655	BEZEL, CAST, 3-1/2 X 8-3/8
101	10109-013	11	58900	10109-013	4-40 X 7/32 PAN
102	HWSS-40300	11	58900	HWSS-40300	#4 X 3/16 SPLIT LOCK
103	HBFP-44006	4	58900	HBFP-44006	4-40 X 3/8 FLAT
104	HNKS-44004	4	96906	MS35649-***	4-40 KEP NUT
105	WKA0-75000	2	92194	FIT-221-3/4	3/4 SHRINK TUBING
A3	21229	1	58900	21229	FRONT PANEL PCB ASSY
A4	21240	1	58900	21240	LCD DISPLAY ASSY
W2	21217	1	58900	21217	CABLE ASSY,CPU-FR PNL
W4	21198	1	58900	21198	CABLE ASSY,CAL
W5	21199	1	58900	21199	CABLE ASSY, SENSOR INPUT

8542C DUAL CHANNEL POWER METER, Rev: C

Item	Part Number	Qty	Cage	Mfr's Part Number	Description
1	30172	1	58900	30172	CHASSIS ASSY - 8542C
2	30280	1	58900	30280	SERIES 8540C OPER/MAINT MANUAL
3	WMP0-03007	1	16428	17250	7.5' IEC POWER CORD
4	20954-001	2	54516	20954-001	DET EXT CABLE ASSY 1.5M (5 FT)
5	30614	1	58900	30614	STANDARD COVER
6	21205	2	62559	10603-023	TIP-UP FOOT
7	21206	2	62559	10603-024	GRAY FOOT
8	21301	2	58900	21301	SIDE TRIM, 8540
9	21118	1	58900	21118	LABEL, TESTED BY
10	21324	22	58900	21324	GROUND STRIP
11	HBPP-44004	3	26233	NS137CR440R4	4-40 X 1/4 PAN
12	HBPP-44006	4	26233	NS137CR440R6	4-40 X 3/8 PAN
13	30016	REF	58900	30016	8540 SYSTEM TEST PROCED

30172 CHASSIS ASSY - 8542C, Rev: J

Item	Part Number	Qty	Cage	Mfr's Part Number	Description
1	30170	1	58900	30170	8542C FRONT DEC PANEL
2	21200	1	58900	21200	CHASSIS
3	30506	1	0JBU8	30506	854X TOROIDAL PWR XFMR
4	21215	1	05245	6EDL4C	AC INPUT MODULE
5	20070	1	58900	20070	250VAC PUSHBUTTON SWITCH
6	30161	REF	58900	30161	8540C SERIES SCHEMATIC
7	10129	1	58900	10129	LABEL, CODE AND SERIAL NUMBER
8	30508	1	58900	30508	854XC XFMR SPACER
9	30013	REF	58900	30013	8540 SERIES JIT FLOW CHART
10	13700	1	31918	FSC-BLACK	BLACK BUTTON
11	JMPF-00003	6	09769	60617-1	FEMALE PIN
12	14931-003	1	09769	1-480270-0	6 POSITION SKT HOUSING
13	30449	REF	58900	30449	HIGH VOLTAGE LABEL
14	30438	1	58900	30438	PROM SET,MODEL 854XC
15	21322	4	0HFJ2	27SR0018	NYLON SNAP RIVET
16	21323	1	13103	21323	SILICONE INSULATOR
17	30552	REF	58900	30552	8540C PRETEST PROCEDURE
18	30552	REF	58900	30552	8540C PRETEST PROCEDURE
19	HT00-00409	3	53421	T-18R	4 WHITE CABLE TIE
20	10495-019	1	92194	FIT-221-1 CLEAR	1" CLEAR SHRINK TUBING
21	30017	REF	58900	30017	8540 CABINETIZING PROC
22	12936	1	16428	8723	CABLE SHIELD 4 COND
23	10469-005	0	51705	SLV-130-20	20 GA 'GLASS' SLEEVING
24	WKAC-18708	2	92194	FIT221-1/8 X 1	3/16 X 1/2 SHRINK TUB
25	10131-002	0	92194	297	WIRE BUS BAR 20 GA
26	10495-014	0	92194	FIT-221-1/8-BLACK	1/8" BLACK SHRINK TUBING
27	11438	2	———	SP5303-GRAY	MOLDED BUMPER
101	HBFP-63205	2	58900	HBFP-63205	6-32 X 5/16 FLAT
102	HNSS-63205	2	58900	HNSS-63205	6-32 HEX NUT
103	HBPP-63204	4	58900	HBPP-63204	6-32 X 1/4 PAN
104	10116-004	2	58900	10116-004	SCR, PNH PHILLIPS 2-56x.125
105	JMSF-00003	1	09769	552633-3	IEEE CONN MOUNTING
106	HBFP-83240	1	58900	HBFP-83240	8-32 X 2.5 FLAT
107	HNNS-83205	1	96906	M517828***	8-32 LOCKING NUT
108	10148-002	2	2R182	1415-6	SOLDER LUG, 30 DEG LOCKING #6
A1	21693	1	58900	21693	CPU PCB ASSY 854xB
A2	30173	1	58900	30173	8542C ANALOG PC ASSY
A5	21332	1	58900	21332	FRONT PANEL ASSY, 8542B
F1	FSAC-00075	1	———	MDL-3/4	.75A SB FUSE 3AG
RT1	20033	1	58900	20033	275 V METAL OXIDE VAR
W3	21175-002	1	58900	21175-002	CABLE ASSY,CPU-GPIB

21332 FRONT PANEL ASSY, 8542B, Rev: B

Item	Part Number	Qty	Cage	Mfr's Part Number	Description
1	21153	1	58900	21153	KEY PAD
3	21655	1	———	21655	BEZEL, CAST, 3-1/2 X 8-3/8
101	10109-013	11	58900	10109-013	4-40 X 7/32 PAN
102	HWSS-40300	11	58900	HWSS-40300	#4 X 3/16 SPLIT LOCK
103	HBFP-44006	4	58900	HBFP-44006	4-40 X 3/8 FLAT
104	HNKS-44004	4	96906	MS35649-***	4-40 KEP NUT
105	WKA0-75000	2	92194	FIT-221-3/4	3/4 SHRINK TUBING
A3	21229	1	58900	21229	FRONT PANEL PCB ASSY
A4	21240	1	58900	21240	LCD DISPLAY ASSY
W2	21217	1	58900	21217	CABLE ASSY,CPU-FR PNL
W4	21198	1	58900	21198	CABLE ASSY,CAL
W5	21199	1	58900	21199	CABLE ASSY, SENSOR INPUT
W6	21199	1	58900	21199	CABLE ASSY, SENSOR INPUT

21693 CPU PCB ASSY 854xB (A1), Rev: G

Item	Part Number	Qty	Cage	Mfr's Part Number	Description
3	21719	1	58900	21719	21719 LABEL, CPU 854X
4	21212	1	58900	21212	3.6 VOLT LITHIUM BATTERY
5	11438	8	———	SP5303-GRAY	MOLDED BUMPER
6	21693-A00	1	58900	21693-A00	PCB ASSY PREWAVE, CPU
7	21210	4	58900	21210	PLASTIC LATCH GROMMET
8	21211	4	58900	21211	PLASTIC LATCH PLUNGER
C6	CE16-R8470	1	55680	UVX1C472MHA	4700 UF 16V RADIAL
C9	19598-011	1	55680	UVX1E472MHA	4700UF 25V RADIAL
C12	19598-011	1	55680	UVX1E472MHA	4700UF 25V RADIAL
C54	CE16-R8470	1	55680	UVX1C472MHA	4700 UF 16V RADIAL
C55	20725-001	1	58900	20725-001	470UF 25V RADIAL
J1	21168	1	09769	2-534206-5	50 PIN STRIPLINE SOCKET
J4	21164	1	09769	413524-1	BNC F RT ANG PC MOUNT
J5	21164	1	09769	413524-1	BNC F RT ANG PC MOUNT
J7	21164	1	09769	413524-1	BNC F RT ANG PC MOUNT
R16	21156	1	58900	21156	20K POT 1T PC MOUNT
U4	21699	1	58900	21699	PAL,PROG,MODEL 8540B
U27	21165	1	61802	TC551001BPL-10	TC551001BPL-10 1M RAM
U28	21165	1	61802	TC551001BPL-10	TC551001BPL-10 1M RAM
U37	21557	1	27014	LM2940CT-5	LM2940CT-5 1A 5V REG
U38	21557	1	27014	LM2940CT-5	LM2940CT-5 1A 5V REG
U39	21558	1	27014	LM2940CT-15	LM2940CT-15 1A 15V REG
U40	21559	1	27014	LM2990T-15	LM2990T-15 1A -15V REG
W 3A	17240-001	1	27264	15-38-1024	JUMPER,INSULATED,2 POS
W 3C	17240-001	1	27264	15-38-1024	JUMPER,INSULATED,2 POS
W 3D	17240-001	1	27264	15-38-1024	JUMPER,INSULATED,2 POS
W 3E	17240-001	1	27264	15-38-1024	JUMPER,INSULATED,2 POS
W 3F	17240-001	1	27264	15-38-1024	JUMPER,INSULATED,2 POS
W 3H	17240-001	1	27264	15-38-1024	JUMPER,INSULATED,2 POS

21693-A00 PCB ASSY PREWAVE (A1), CPU, Rev: F

Item	Part Number	Qty	Cage	Mfr's Part Number	Description
1	21694	REF	58900	21694	SCHEMATIC, CPU
2	21094	1	58900	21094	PCB, CPU
3	14514-001	113	58900	14514-001	CONTACT POST
C1	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C2	CE25-R7100	1	00656	AMR101M025	100 UF 25V RADIAL LEAD
C3	CE50-R6100	1	55680	UVX1H100MDA	10 UF 50V RADIAL LEAD
C4	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C5	CE50-R6100	1	55680	UVX1H100MDA	10 UF 50V RADIAL LEAD
C7	11501-005	1	04222	SR301E474MAA	.47 UF CERAMIC Y5V
C8	11501-005	1	04222	SR301E474MAA	.47 UF CERAMIC Y5V
C10	11501-005	1	04222	SR301E474MAA	.47 UF CERAMIC Y5V
C11	11501-005	1	04222	SR301E474MAA	.47 UF CERAMIC Y5V
C13	11501-005	1	04222	SR301E474MAA	.47 UF CERAMIC Y5V
C14	11501-005	1	04222	SR301E474MAA	.47 UF CERAMIC Y5V
C15	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C16	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C17	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C18	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C19	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C20	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C21	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C22	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C23	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C24	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C25	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C26	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C27	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C28	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C29	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C30	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C31	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C32	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C33	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C34	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C35	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C36	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C37	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C38	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C39	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C40	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C42	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C43	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C44	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C45	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C46	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C47	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C48	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C49	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C50	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C51	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C52	11501-005	1	04222	SR301E474MAA	.47 UF CERAMIC Y5V
CR2	DSA0-04148	1	58900	DSA0-04148	1N4148 G.P. DIODE
CR3	DSA0-04148	1	58900	DSA0-04148	1N4148 G.P. DIODE
CR4	DSA0-04148	1	58900	DSA0-04148	1N4148 G.P. DIODE
CR5	DSA0-04148	1	58900	DSA0-04148	1N4148 G.P. DIODE
CR6	12409	1	58900	12409	PE10 5A 100V BRIDGE RECTIFIER
CR7	DBMC-00001	1	0RF16	CSB1	1 A DIP BRIDGE
DS1	ILYR-00125	1	28480	HLMP-1440	YELLOW LED
DS2	ILYR-00125	1	28480	HLMP-1440	YELLOW LED
J2	14514-001	1	58900	14514-001	CONTACT POST
J3	14514-001	1	58900	14514-001	CONTACT POST
J6	19477-011	1	09769	1-640456-6	16 PIN LOCKING STRIP PLUG
J8	16570	1	09769	2-87227-5	50 PIN STRIPLINE PLUG

21693-A00 PCB ASSY PREWAVE (A1), CPU, Rev: F

Item	Part Number	Qty	Cage	Mfr's Part Number	Description
J9	19183-001	1	09769	1-380999-0	6 PIN MALE CONNECTOR
J10	14514-001	1	58900	14514-001	CONTACT POST
J11	19477-003	1	09769	640456-4	CONN HDR POST STR LOCK 4POS
Q1	QBNS-03904	1	04713	2N3904	2N3904 .2A 40V NPN
R1	RN55-14750	1	91637	RN55C4751F	4.75 K OHMS 1% MET FILM
R2	RN55-22000	1	91637	RN55C2002F	20 K OHMS 1% MET FILM
R3	RN55-21000	1	91637	RN55C1002F	10 K OHMS 1% MET FILM
R4	RN55-21000	1	91637	RN55C1002F	10 K OHMS 1% MET FILM
R5	RN55-21000	1	91637	RN55C1002F	10 K OHMS 1% MET FILM
R6	RN55-02210	1	91637	RN55C2210F	221 OHMS 1% MET FILM
R10	RN55-02210	1	91637	RN55C2210F	221 OHMS 1% MET FILM
R11	RN55-04750	1	91637	RN55C4750F	475 OHMS 1% MET FILM
R12	RN55-21000	1	91637	RN55C1002F	10 K OHMS 1% MET FILM
R13	RN55-04750	1	91637	RN55C4750F	475 OHMS 1% MET FILM
R14	RN55-21000	1	91637	RN55C1002F	10 K OHMS 1% MET FILM
R18	RN55-14750	1	91637	RN55C4751F	4.75 K OHMS 1% MET FILM
R19	RN55-01000	1	91637	RN55C1000F	100 OHMS 1% MET FILM
R20	RN55-21000	1	91637	RN55C1002F	10 K OHMS 1% MET FILM
R21	RN55-21000	1	91637	RN55C1002F	10 K OHMS 1% MET FILM
R22	RN55-31000	1	91637	RN55C1003F	100 K OHMS 1% MET FILM
R23	RN55-31000	1	91637	RN55C1003F	100 K OHMS 1% MET FILM
R24	RN55-31000	1	91637	RN55C1003F	100 K OHMS 1% MET FILM
R25	RN55-31000	1	91637	RN55C1003F	100 K OHMS 1% MET FILM
R26	RN55-00100	1	91637	RN55C10R0F	10 OHMS 1% MET FILM
R27	RN55-00100	1	91637	RN55C10R0F	10 OHMS 1% MET FILM
R28	RN55-00100	1	91637	RN55C10R0F	10 OHMS 1% MET FILM
R29	RN55-11000	1	91637	RN55C1001F	1 K OHMS 1% MET FILM
RP1	14882-001	1	58900	14882-001	10K OHM X 9 SIP NETWORK
RP2	14882-001	1	58900	14882-001	10K OHM X 9 SIP NETWORK
RP3	14882-001	1	58900	14882-001	10K OHM X 9 SIP NETWORK
RP4	14882-001	1	58900	14882-001	10K OHM X 9 SIP NETWORK
RP5	14882-001	1	58900	14882-001	10K OHM X 9 SIP NETWORK
RP6	14882-001	1	58900	14882-001	10K OHM X 9 SIP NETWORK
TP1	14320-002	1	63345	330.100W/ TIN PLATE	TEST JACK PIN
TP2	14320-002	1	63345	330.100W/ TIN PLATE	TEST JACK PIN
TP3	14320-002	1	63345	330.100W/ TIN PLATE	TEST JACK PIN
TP4	14320-002	1	63345	330.100W/ TIN PLATE	TEST JACK PIN
TP5	14320-002	1	63345	330.100W/ TIN PLATE	TEST JACK PIN
TP6	14320-002	1	63345	330.100W/ TIN PLATE	TEST JACK PIN
TP7	14320-002	1	63345	330.100W/ TIN PLATE	TEST JACK PIN
TP8	14320-002	1	63345	330.100W/ TIN PLATE	TEST JACK PIN
TP12	14320-002	1	63345	330.100W/ TIN PLATE	TEST JACK PIN
TP13	14320-002	1	63345	330.100W/ TIN PLATE	TEST JACK PIN
TP14	14320-002	1	63345	330.100W/ TIN PLATE	TEST JACK PIN
TP15	14320-002	1	63345	330.100W/ TIN PLATE	TEST JACK PIN
TP16	14320-002	1	63345	330.100W/ TIN PLATE	TEST JACK PIN
TP17	14320-002	1	63345	330.100W/ TIN PLATE	TEST JACK PIN
TP18	14320-002	1	63345	330.100W/ TIN PLATE	TEST JACK PIN
U1	UTN0-00742	1	58900	UTN0-00742	74HC74 DUAL D FLIP FLOP
U2	UTN0-03932	1	01295	SN74HC393N	74HC393 BINARY DIVIDE
U3	21159	1	4T165	UPD71055C	uPD71055 PARALLEL INTERFACE
U6	UIN0-75160	1	01295	SN75160BN	SN75160N IEEE BUFFER
U7	UIN0-75162	1	01295	SN75162BN	SN75162N IEEE BUFFER
U8	UGN0-09914	1	01295	TMS9914NL (ANL)	TMS9914NL IEEE-488
U9	UGN0-68000	1	04713	MC68HC000P-12	HD68HC000P-8 COMPUTER
U10	21162	1	0B0A9	DS1210	DS1210 NONVOL CONTROLLER
U11	UTN0-00322	1	01295	74HC32N	74HC32 QUAD 2 INPUT OR
U12	UTN0-02453	1	01295	SN74HCT245N	74HCT245 OCTAL BUSXCVR
U13	UTN0-02453	1	01295	SN74HCT245N	74HCT245 OCTAL BUSXCVR
U14	UTN0-02443	1	01295	SN74HCT244N	SN74HCT244N BUFFER
U15	UTN0-01382	1	01295	74HC138N	74HC138 DECODER/DEMULTIP
U16	UTN0-00322	1	01295	74HC32N	74HC32 QUAD 2 INPUT OR
U17	UTN0-00042	1	01295	SN74HC04N	SN74HC04 HEX INVERTER

21693-A00 PCB ASSY PREWAVE (A1), CPU, Rev: F

Item	Part Number	Qty	Cage	Mfr's Part Number	Description
U18	UTN0-01382	1	01295	74HC138N	74HC138 DECODER/DEMULTIP
U19	UTN0-01382	1	01295	74HC138N	74HC138 DECODER/DEMULTIP
U20	UTN0-00052	1	01295	SN74HC05N	74HC05, HEX INVERTER
U21	UTN0-01482	1	01295	SN74HC148N	74HC148 PRIORITY ENCODER
U22	21163	1	0B0A9	DS1231-50	DS1231-50 POWER MONITOR
U23	17024	1	34335	AM8279DC	8279 KEY/DISPLAY INTERFACE
U24	17048-014	1	58900	17048-014	74HCT14N HEX SCHMITT TRIGGER
U25	21159	1	4T165	UPD71055C	uPD71055 PARALLEL INTERFACE
U26	21158	1	4T165	UPD71054C	uPD71054C PROG COUNTER
W3	14514-001	1	58900	14514-001	CONTACT POST
W4	14514-001	1	58900	14514-001	CONTACT POST
XU4	JSP0-10020	1	09769	2-641612-1	20 PIN DIP SOCKET
XU27	JSP0-10032	1	09769	2-644018-1	32 PIN DIP SOCKET
XU28	JSP0-10032	1	09769	2-644018-1	32 PIN DIP SOCKET
XU29	JSP0-10032	1	09769	2-644018-1	32 PIN DIP SOCKET
XU30	JSP0-10032	1	09769	2-644018-1	32 PIN DIP SOCKET
XU31	JSP0-10032	1	09769	2-644018-1	32 PIN DIP SOCKET
XU32	JSP0-10032	1	09769	2-644018-1	32 PIN DIP SOCKET
XU33	JSP0-10032	1	09769	2-644018-1	32 PIN DIP SOCKET
XU34	JSP0-10032	1	09769	2-644018-1	32 PIN DIP SOCKET
XU35	JSP0-10032	1	09769	2-644018-1	32 PIN DIP SOCKET
XU36	JSP0-10032	1	09769	2-644018-1	32 PIN DIP SOCKET
Y1	21166	1	61429	F1100H 24.0000MHz	24 MHZ OSCILLATOR

30164 8541C ANALOG P.C. ASSY (A2), Rev: K

Item	Part Number	Qty	Cage	Mfr's Part Number	Description
1	11438	6	——-	SP5303-GRAY	MOLDED BUMPER
2	20192	1	58900	20192	SHELL,OBLONG
3	20259	1	58900	20259	COVER,CALIBRATOR HOUSING
4	20260	1	58900	20260	HOUSING,CALIBRATOR
5	20800	1	58900	20800	LABEL,US PATENT 4,794,325
7	21210	4	58900	21210	PLASTIC LATCH GROMMET
8	21211	4	58900	21211	PLASTIC LATCH PLUNGER
9	HBPP-44004	12	26233	NS137CR440R4	4-40 X 1/4 PAN
10	HWSS-40300	12	58900	HWSS-40300	#4 X 3/16 SPLIT LOCK
11	10479	1	——	4504-3/4"	3/4 X 1/4 FOAM TAPE
12	30163	1	58900	30163	8540C ANALOG PCB
13	30165	REF	58900	30165	8540C ANALOG P.C.B. SCH.
14	PH00-00001	1	4J674	44-CBS-1.5X5.5X.4	SHIELD COVER
15	30166	REF	58900	30166	8540C ANALOG P.C.B. TEST PLAN
16	WTT0-22001	0	16428	#22AWG-TFE/TW	#22 CLEAR TFE SLVNG
A1	20112	1	58900	20112	CALIB THERM OVEN PCB ASSY
C1	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C2	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C3	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C4	21627-001	1	04222	TAJD106M025R	10 UF 25V TANTALUM SMT
C5	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C6	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C7	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C8	21627-001	1	04222	TAJD106M025R	10 UF 25V TANTALUM SMT
C9	21627-001	1	04222	TAJD106M025R	10 UF 25V TANTALUM SMT
C10	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C11	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C14	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C15	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C16	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C17	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C18	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C19	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C20	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C21	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C22	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C23	CK51-05220	1	58900	CK51-05220	2.2 UF Y5V CHIP CERAMIC
C24	CK51-05220	1	58900	CK51-05220	2.2 UF Y5V CHIP CERAMIC
C25	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C26	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C27	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C28	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C31	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C32	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C33	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C34	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C35	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C36	10001-005	1	——	CCD-330	33 PF 1KV CERAMIC NPO
C37	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C38	CC50-04220	1	31433	C322C224M5U5CA	.22 UF CERAMIC Z5U
C39	20032-001	1	58900	20032-001	.47UF 100V POLYPROPYLENE
C40	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C41	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C42	CE50-R5470	1	55680	USA1H4R7MCA	4.7UF 50V RADIAL
C43	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C44	CE50-R5470	1	55680	USA1H4R7MCA	4.7UF 50V RADIAL
C45	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C46	CE50-R5470	1	55680	USA1H4R7MCA	4.7UF 50V RADIAL
C47	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C48	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C49	CC50-02220	1	04222	SR155C222KAA	2200PF CERAMIC X7R
C50	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C51	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R

30164 8541C ANALOG P.C. ASSY (A2), Rev: K

Item	Part Number	Qty	Cage	Mfr's Part Number	Description
C52	10909-013	1	——	DM15-151F	150 PF DIP MICA
C53	10909-018	1	——	DM15-241F	240 PF DIP MICA
C54	CC50-02220	1	04222	SR155C222KAA	2200PF CERAMIC X7R
C55	10909-011	1	——	CMO5FD620F03	62 PF DIP MICA
C56	10909-012	1	——	CMO6FD121J03	120 PF DIP MICA
C57	10909-011	1	——	CMO5FD620F03	62 PF DIP MICA
C58	10677-018	1	——	CM05E102	1000 PF DIP MICA
C59	CC50-02220	1	04222	SR155C222KAA	2200PF CERAMIC X7R
C60	CC50-02220	1	04222	SR155C222KAA	2200PF CERAMIC X7R
C61	15640-012	1	04222	SR201A222KAA	2200 PF CERAMIC COG
C62	15640-012	1	04222	SR201A222KAA	2200 PF CERAMIC COG
C63	10677-018	1	——	CM05E102	1000 PF DIP MICA
C64	CC50-01100	1	04222	SR151A101JAA	100 PF CERAMIC NPO
C65	CC50-01100	1	04222	SR151A101JAA	100 PF CERAMIC NPO
C66	CC50-01100	1	04222	SR151A101JAA	100 PF CERAMIC NPO
C67	15640-012	1	04222	SR201A222KAA	2200 PF CERAMIC COG
C68	15640-012	1	04222	SR201A222KAA	2200 PF CERAMIC COG
C69	15640-012	1	04222	SR201A222KAA	2200 PF CERAMIC COG
C70	15640-012	1	04222	SR201A222KAA	2200 PF CERAMIC COG
C71	CC50-02470	1	31433	C315C472K1R5CA	4700 PF CERAMIC X7R
C72	CC50-01100	1	04222	SR151A101JAA	100 PF CERAMIC NPO
C73	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C74	CC50-02470	1	31433	C315C472K1R5CA	4700 PF CERAMIC X7R
C75	CC50-04220	1	31433	C322C224M5U5CA	.22 UF CERAMIC Z5U
C77	CC50-02220	1	04222	SR155C222KAA	2200PF CERAMIC X7R
C78	CC50-02100	1	04222	SR155C122MAT	.001 UF CERAMIC Y5P
C79	CC50-01100	1	04222	SR151A101JAA	100 PF CERAMIC NPO
C80	CC50-02220	1	04222	SR155C222KAA	2200PF CERAMIC X7R
C81	CC50-02220	1	04222	SR155C222KAA	2200PF CERAMIC X7R
C82	CC50-02220	1	04222	SR155C222KAA	2200PF CERAMIC X7R
C83	CC50-02220	1	04222	SR155C222KAA	2200PF CERAMIC X7R
C84	CC50-03470	1	31433	C320C473K5R5CA	.047 UF CERAMIC X7R
C85	CC50-02220	1	04222	SR155C222KAA	2200PF CERAMIC X7R
C86	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C87	CC50-02100	1	04222	SR155C122MAT	.001 UF CERAMIC Y5P
C88	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C89	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C90	CK50-00100	1	54583	CC0805HNPO15150J	10 PF NPO CHIP
C91	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C92	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C93	CK50-00100	1	54583	CC0805HNPO15150J	10 PF NPO CHIP
C94	CK51-05220	1	58900	CK51-05220	2.2 UF Y5V CHIP CERAMIC
C98	CK51-05220	1	58900	CK51-05220	2.2 UF Y5V CHIP CERAMIC
C100	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C101	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C102	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C104	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C105	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C106	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C107	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C108	CK51-02100	1	04222	08055C102KATMA	1000PF X7R CHIP CERAMIC
C109	CK51-05220	1	58900	CK51-05220	2.2 UF Y5V CHIP CERAMIC
C110	21627-001	1	04222	TAJD106M025R	10 UF 25V TANTALUM SMT
C111	21627-001	1	04222	TAJD106M025R	10 UF 25V TANTALUM SMT
C113	CK51-05220	1	58900	CK51-05220	2.2 UF Y5V CHIP CERAMIC
C124	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C125	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C126	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C127	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C128	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C129	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C130	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C131	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R

30164 8541C ANALOG P.C. ASSY (A2), Rev: K

Item	Part Number	Qty	Cage	Mfr's Part Number	Description
C132	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C133	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C134	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C135	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C136	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C137	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C138	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C139	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C140	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C141	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C142	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C143	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C144	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C145	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C146	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C147	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C148	CK50-03100	1	31433	C0805C103K5RAC	.01 UF X7R CHIP
C149	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C150	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C151	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C152	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C153	21627-001	1	04222	TAJD106M025R	10 UF 25V TANTALUM SMT
C154	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C155	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C156	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C159	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C160	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C161	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C162	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C163	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C164	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C165	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C166	CE50-R6100	1	55680	UVX1H100MDA	10 UF 50V RADIAL LEAD
C167	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C168	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C171	21627-001	1	04222	TAJD106M025R	10 UF 25V TANTALUM SMT
C172	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C175	21627-001	1	04222	TAJD106M025R	10 UF 25V TANTALUM SMT
C176	21627-001	1	04222	TAJD106M025R	10 UF 25V TANTALUM SMT
C177	CC50-04220	1	31433	C322C224M5U5CA	.22 UF CERAMIC Z5U
C178	CK51-02100	1	04222	08055C102KATMA	1000PF X7R CHIP CERAMIC
C180	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C181	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C191	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C202	21627-001	1	04222	TAJD106M025R	10 UF 25V TANTALUM SMT
C203	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C204	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C205	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C206	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C207	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C209	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C210	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C211	21627-001	1	04222	TAJD106M025R	10 UF 25V TANTALUM SMT
C228	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C229	CK50-01100	1	58900	CK50-01100	100 PF CERAMIC NPO
C230	CK50-03100	1	31433	C0805C103K5RAC	.01 UF X7R CHIP
C231	CK50-01470	1	58900	CK50-01470	470PF COG CHIP CERAMIC
C232	CK50-03100	1	31433	C0805C103K5RAC	.01 UF X7R CHIP
C233	CK50-03100	1	31433	C0805C103K5RAC	.01 UF X7R CHIP
C234	CK50-03100	1	31433	C0805C103K5RAC	.01 UF X7R CHIP
C235	CK50-03100	1	31433	C0805C103K5RAC	.01 UF X7R CHIP
C236	CK50-03100	1	31433	C0805C103K5RAC	.01 UF X7R CHIP
C237	CK50-03100	1	31433	C0805C103K5RAC	.01 UF X7R CHIP

30164 8541C ANALOG P.C. ASSY (A2), Rev: K

Item	Part Number	Qty	Cage	Mfr's Part Number	Description
C238	CK50-03100	1	31433	C0805C103K5RAC	.01 UF X7R CHIP
C239	CK50-03100	1	31433	C0805C103K5RAC	.01 UF X7R CHIP
C240	CK50-03100	1	31433	C0805C103K5RAC	.01 UF X7R CHIP
C241	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C243	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C246	CK50-01470	1	58900	CK50-01470	470PF COG CHIP CERAMIC
CR2	DSA0-04148	1	58900	DSA0-04148	1N4148 G.P. DIODE
CR3	DSA0-04148	1	58900	DSA0-04148	1N4148 G.P. DIODE
CR4	DSA0-04148	1	58900	DSA0-04148	1N4148 G.P. DIODE
CR5	DSA0-04148	1	58900	DSA0-04148	1N4148 G.P. DIODE
CR6	DSA0-04148	1	58900	DSA0-04148	1N4148 G.P. DIODE
CR7	DSA0-04148	1	58900	DSA0-04148	1N4148 G.P. DIODE
CR8	13618	1	58900	13618	DIODE,uWAVE PIN SW,.3PF,100ns
CR9	13618	1	58900	13618	DIODE,uWAVE PIN SW,.3PF,100ns
CR10	13618	1	58900	13618	DIODE,uWAVE PIN SW,.3PF,100ns
CR11	13618	1	58900	13618	DIODE,uWAVE PIN SW,.3PF,100ns
CR12	13618	1	58900	13618	DIODE,uWAVE PIN SW,.3PF,100ns
CR13	13618	1	58900	13618	DIODE,uWAVE PIN SW,.3PF,100ns
CR14	13618	1	58900	13618	DIODE,uWAVE PIN SW,.3PF,100ns
CR15	DSA0-04148	1	58900	DSA0-04148	1N4148 G.P. DIODE
CR20	DZAB-00751	1	04713	1N751A	1N751A 5.1V ZENER
J1	19941-001	1	09769	102975-7	14 PIN STRIPLINE PLUG
J3	21164	1	09769	413524-1	BNC F RT ANG PC MOUNT
J4	21164	1	09769	413524-1	BNC F RT ANG PC MOUNT
J5	JRBM-00100	1	58900	JRBM-00100	SMB M PC MOUNT
L11	10631-010	1	58900	10631-010	6.8 UH INDUCTOR
L12	19203	1	OB3G8	19203	.1 UH RF COIL
L13	15293	1	58900	15293	.17 UH INDUCTOR
L14	15293	1	58900	15293	.17 UH INDUCTOR
L15	15293	1	58900	15293	.17 UH INDUCTOR
L16	10631-010	1	58900	10631-010	6.8 UH INDUCTOR
L17	10631-010	1	58900	10631-010	6.8 UH INDUCTOR
L18	10631-010	1	58900	10631-010	6.8 UH INDUCTOR
P1	16570	1	09769	2-87227-5	50 PIN STRIPLINE PLUG
Q1	QBPP-00170	1	04713	MJE 170	MJE 170 3A 40V 12.5W PNP
Q2	QBNS-03904	1	04713	2N3904	2N3904 .2A 40V NPN
Q3	QBNS-03904	1	04713	2N3904	2N3904 .2A 40V NPN
Q4	20242	1	01295	2N3553	2N3553 2.5W 175 MHZ NPN
Q5	10023	1	58900	10023	2N3644 .3 A 45 V PNP
Q6	10017	1	4U751	2N3569	PN3569 .5A 40V NPN
Q7	10017	1	4U751	2N3569	PN3569 .5A 40V NPN
Q8	20850	1	04713	MMBT3904L	TRANSISTOR NPN 3904 (SOT-23)
Q9	QJNS-04416	1	04713	MMBF4416L	MMBF4416L FET AMP SMT
Q10	QJNS-04416	1	04713	MMBF4416L	MMBF4416L FET AMP SMT
Q11	QJNS-04416	1	04713	MMBF4416L	MMBF4416L FET AMP SMT
Q12	QJNS-04416	1	04713	MMBF4416L	MMBF4416L FET AMP SMT
Q13	QJNS-04416	1	04713	MMBF4416L	MMBF4416L FET AMP SMT
Q14	QJNS-04416	1	04713	MMBF4416L	MMBF4416L FET AMP SMT
Q15	QJNS-04416	1	04713	MMBF4416L	MMBF4416L FET AMP SMT
Q16	QJNS-04416	1	04713	MMBF4416L	MMBF4416L FET AMP SMT
R2	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R3	RK45-05490	1	59124	RN73K2A5490F	549 OHM 1% FILM SMT
R4	RK45-01800	1	59124	RN73K2A1800F	180 OHM 1% FILM SMT
R5	RK45-03160	1	59124	RN73K2A3160F	316 OHM 1% FILM SMT
R6	RK45-01800	1	59124	RN73K2A1800F	180 OHM 1% FILM SMT
R7	RK45-01800	1	59124	RN73K2A1800F	180 OHM 1% FILM SMT
R8	RK45-01800	1	59124	RN73K2A1800F	180 OHM 1% FILM SMT
R9	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R10	RK45-01800	1	59124	RN73K2A1800F	180 OHM 1% FILM SMT
R11	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R12	RK45-05490	1	59124	RN73K2A5490F	549 OHM 1% FILM SMT
R13	RK45-03160	1	59124	RN73K2A3160F	316 OHM 1% FILM SMT
R14	RK45-01800	1	59124	RN73K2A1800F	180 OHM 1% FILM SMT

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Item	Part Number	Qty	Cage	Mfr's Part Number	Description
R15	RK45-01800	1	59124	RN73K2A1800F	180 OHM 1% FILM SMT
R16	RK45-01800	1	59124	RN73K2A1800F	180 OHM 1% FILM SMT
R17	RK45-31470	1	91637	CRCW08051473FT	147K OHM 1% FILM SMT
R18	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R19	RK45-02870	1	58900	RK45-02870	287 OHM 1% FILM SMT
R20	RK45-32490	1	59124	RN73K2A2493F	249K OHM 1% FILM SMT
R21	RK45-21470	1	58900	RK45-21470	14.7K OHM 1% FILM SMT
R22	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R23	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R24	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R25	RK45-00681	1	59124	RN73K2A68R1F	68.1 OHM 1% FILM SMT
R26	RK45-00681	1	59124	RN73K2A68R1F	68.1 OHM 1% FILM SMT
R27	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R28	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R29	RK45-13320	1	91637	CRCW08053321FT	3.32K OHM 1% FILM SMT
R30	RN55-11000	1	91637	RN55C1001F	1 K OHMS 1% MET FILM
R31	RN55-03320	1	91637	RN55C3320F	332 OHMS 1% MET FILM
R32	RN55-03320	1	91637	RN55C3320F	332 OHMS 1% MET FILM
R33	RN55-11820	1	91637	RN55C1821F	1.82 K OHMS 1% MET FILM
R34	21445-002	1	——-	RK73H2AT1003F	100K OHM 1% FILM SMT
R35	RN55-14750	1	91637	RN55C4751F	4.75 K OHMS 1% MET FILM
R36	RK45-05490	1	59124	RN73K2A5490F	549 OHM 1% FILM SMT
R37	RK45-32490	1	59124	RN73K2A2493F	249K OHM 1% FILM SMT
R38	RK45-14420	1	58900	RK45-14420	4.42K OHM 1% FILM SMT
R39	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R40	RK45-32490	1	59124	RN73K2A2493F	249K OHM 1% FILM SMT
R41	RK45-32490	1	59124	RN73K2A2493F	249K OHM 1% FILM SMT
R42	RK45-13320	1	91637	CRCW08053321FT	3.32K OHM 1% FILM SMT
R43	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R44	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R46	RK45-22670	1	58900	RK45-22670	26.7K OHM 1% FILM SMT
R47	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R48	21445-009	1	——-	RK73H2AT4990F	499 OHM 1% FILM SMT
R50	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R51	RK45-23010	1	91637	CRCW08053012FT	30.1K OHM 1% FILM SMT
R52	21445-011	1	——-	RK73H2AT1002F	10.0K OHM 1% FILM SMT
R53	RK45-23010	1	91637	CRCW08053012FT	30.1K OHM 1% FILM SMT
R59	RK45-23010	1	91637	CRCW08053012FT	30.1K OHM 1% FILM SMT
R62	21445-011	1	——-	RK73H2AT1002F	10.0K OHM 1% FILM SMT
R63	RK45-00412	1	58900	RK45-00412	41.2 OHM 1% FILM SMT
R64	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R65	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R66	21445-009	1	——-	RK73H2AT4990F	499 OHM 1% FILM SMT
R67	21445-009	1	——-	RK73H2AT4990F	499 OHM 1% FILM SMT
R68	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R69	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R70	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R73	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R77	21445-011	1	——	RK73H2AT1002F	10.0K OHM 1% FILM SMT
R78	21445-011	1	——	RK73H2AT1002F	10.0K OHM 1% FILM SMT
R96	21445-002	1	——	RK73H2AT1003F	100K OHM 1% FILM SMT
R97	RN55-11820	1	91637	RN55C1821F	1.82 K OHMS 1% MET FILM
R98	RN55-14750	1	91637	RN55C4751F	4.75 K OHMS 1% MET FILM
R99	RN55-00274	1	91637	RN55C27R4F	27.4 OHMS 1% MET FILM
R100	12449-053	1	58900	12449-053	50.0 K OHM .1 % MET FILM
R101	12449-053	1	58900	12449-053	50.0 K OHM .1 % MET FILM
R102	12449-053	1	58900	12449-053	50.0 K OHM .1 % MET FILM
R103	12449-053	1	58900	12449-053	50.0 K OHM .1 % MET FILM
R106	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R107	RN55-21000	1	91637	RN55C1002F	10 K OHMS 1% MET FILM
R108	RN55-03920	1	91637	RN55C3920F	392 OHMS 1% MET FILM
R109	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R110	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT

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Item	Part Number	Qty	Cage	Mfr's Part Number	Description
R111	RK45-05490	1	59124	RN73K2A5490F	549 OHM 1% FILM SMT
R112	RK45-21470	1	58900	RK45-21470	14.7K OHM 1% FILM SMT
R113	RN55-24750	1	91637	RN55C4752F	47.5 K OHMS 1% MET FILM
R114	RN55-11000	1	91637	RN55C1001F	1 K OHMS 1% MET FILM
R115	10015-064	1	91637	RN55D 1.13K OHM 1%	1.13 K OHMS 1% MET FILM
R117	12449-048	1	58900	12449-048	15.0 K OHM .1 % MET FILM
R118	12449-032	1	58900	12449-032	1.25 K OHM .1% MET FILM
R119	12449-028	1	58900	12449-028	12.5 K OHM .1% MET FILM
R120	RN55-21000	1	91637	RN55C1002F	10 K OHMS 1% MET FILM
R121	RN55-41000	1	91637	RN55C1004F	1 M OHMS 1% MET FILM
R122	RN55-14750	1	91637	RN55C4751F	4.75 K OHMS 1% MET FILM
R123	RN55-21000	1	91637	RN55C1002F	10 K OHMS 1% MET FILM
R124	RN55-14750	1	91637	RN55C4751F	4.75 K OHMS 1% MET FILM
R125	RN55-14750	1	91637	RN55C4751F	4.75 K OHMS 1% MET FILM
R126	12449-128	1	58900	12449-128	13.33 K OHM .1 % MET FILM
R127	12449-129	1	58900	12449-129	40.0 K OHM .1 % MET FILM
R128	RN55-12210	1	91637	RN55C2211F	2.21 K OHMS 1% MET FILM
R129	RK45-31470	1	91637	CRCW08051473FT	147K OHM 1% FILM SMT
R130	RK45-22670	1	58900	RK45-22670	26.7K OHM 1% FILM SMT
R131	RN55-12000	1	91637	RN55C2001F	2.00 K OHMS 1% MET FILM
R132	RN55-12000	1	91637	RN55C2001F	2.00 K OHMS 1% MET FILM
R133	RN55-11000	1	91637	RN55C1001F	1 K OHMS 1% MET FILM
R134	RN55-13010	1	91637	RN55C3011F	3.01 K OHMS 1% MET FILM
R135	RN55-22210	1	91637	RN55C2212F	22.1 K OHMS 1% MET FILM
R136	RN55-23160	1	91637	RN55C3162F	31.6 K OHMS 1% MET FILM
R137	RN55-21330	1	91637	RN55C1332F	13.3 K OHMS 1% MET FILM
R138	RK45-13320	1	91637	CRCW08053321FT	3.32K OHM 1% FILM SMT
R139	RN55-11000	1	91637	RN55C1001F	1 K OHMS 1% MET FILM
R140	RN55-14990	1	91637	RN55C4991F	4.99 K OHMS 1% MET FILM
R141	12449-090	1	58900	12449-090	8.00 K OHM .1 % MET FILM
R142	RN55-21000	1	91637	RN55C1002F	10 K OHMS 1% MET FILM
R143	RN55-21000	1	91637	RN55C1002F	10 K OHMS 1% MET FILM
R144	RN55-00274	1	91637	RN55C27R4F	27.4 OHMS 1% MET FILM
R145	RK45-02870	1	58900	RK45-02870	287 OHM 1% FILM SMT
R146	RN55-12490	1	91637	RN55C2491F	2.49 K OHMS 1% MET FILM
R147	RN55-12490	1	91637	RN55C2491F	2.49 K OHMS 1% MET FILM
R148	RN55-21210	1	91637	RN55C1212F	12.1 K OHMS 1% MET FILM
R149	RN55-21000	1	91637	RN55C1002F	10 K OHMS 1% MET FILM
R150	RN55-03740	1	91637	RN55C3740F	374 OHMS 1% MET FILM
R151	RN55-03740	1	91637	RN55C3740F	374 OHMS 1% MET FILM
R152	RN55-11000	1	91637	RN55C1001F	1 K OHMS 1% MET FILM
R153	RN55-11000	1	91637	RN55C1001F	1 K OHMS 1% MET FILM
R154	RN55-11000	1	91637	RN55C1001F	1 K OHMS 1% MET FILM
R155	RN55-04990	1	91637	RN55C4990F	499 OHMS 1% MET FILM
R156	RN55-04990	1	91637	RN55C4990F	499 OHMS 1% MET FILM
R157	10015-082	1	91637	CCF55-2-61.9^1%T2T/R	61.9 OHMS 1% MET FILM
R158	10015-144	1	91637	RN55D 95.3 OHM 1%	95.3 OHM 1% MET FILM
R159	10015-144	1	91637	RN55D 95.3 OHM 1%	95.3 OHM 1% MET FILM
R160	RN55-11500	1	91637	RN55C1501F	1.5 K OHMS 1% MET FILM
R161	RN55-11000	1	91637	RN55C1001F	1 K OHMS 1% MET FILM
R162	10015-125	1	91637	CCF55-2-28.7^1%T2T/R	28.7 OHMS 1% MET FILM
R163	RN55-00110	1	91637	RN55C11R0F	11.0 OHMS 1% MET FILM
R164	RN55-11000	1	91637	RN55C1001F	1 K OHMS 1% MET FILM
R165	RN55-04990	1	91637	RN55C4990F	499 OHMS 1% MET FILM
R166	10015-082	1	91637	CCF55-2-61.9^1%T2T/R	61.9 OHMS 1% MET FILM
R167	RN55-02430	1	91637	RN55C2430F	243 OHMS 1% MET FILM
R168	RN55-11000	1	91637	RN55C1001F	1 K OHMS 1% MET FILM
R169	RN55-04990	1	91637	RN55C4990F	499 OHMS 1% MET FILM
R170	10015-082	1	91637	CCF55-2-61.9^1%T2T/R	61.9 OHMS 1% MET FILM
R171	RN55-23010	1	91637	RN55C3012F	30.1 K OHMS 1% MET FILM
R172	RN55-31100	1	91637	RN55C1103F	110 K OHMS 1% MET FILM
R173	RN55-12740	1	91637	RN55C2741F	2.74K OHMS 1% MET FILM
R174	11845-004	1	91637	FP215R0 5%	15 OHM 10% METAL GLAZE

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Item	Part Number	Qty	Cage	Mfr's Part Number	Description
R175	RN55-11500	1	91637	RN55C1501F	1.5 K OHMS 1% MET FILM
R176	RN55-21000	1	91637	RN55C1002F	10 K OHMS 1% MET FILM
R177	RN55-21000	1	91637	RN55C1002F	10 K OHMS 1% MET FILM
R178	RN55-21000	1	91637	RN55C1002F	10 K OHMS 1% MET FILM
R179	RN55-22210	1	91637	RN55C2212F	22.1 K OHMS 1% MET FILM
R180	RN55-21500	1	91637	RN55C1502F	15 K OHMS 1% MET FILM
R181	RN55-14750	1	91637	RN55C4751F	4.75 K OHMS 1% MET FILM
R182	RN55-14750	1	91637	RN55C4751F	4.75 K OHMS 1% MET FILM
R183	RN55-02490	1	91637	RN55C2490F	249 OHMS 1% MET FILM
R184	RN55-34750	1	91637	RN55C4753F	475 K OHMS 1% MET FILM
R185	RN55-11000	1	91637	RN55C1001F	1 K OHMS 1% MET FILM
R186	RN55-12000	1	91637	RN55C2001F	2.00 K OHMS 1% MET FILM
R187	RN55-00100	1	91637	RN55C10R0F	10 OHMS 1% MET FILM
R188	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R189	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R190	RK45-00576	1	59124	RN73K2A57R6F	57.6 OHM 1% FILM SMT
R191	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R194	21445-011	1	——	RK73H2AT1002F	10.0K OHM 1% FILM SMT
R195	21445-011	1	——	RK73H2AT1002F	10.0K OHM 1% FILM SMT
R198	RN55-01000	1	91637	RN55C1000F	100 OHMS 1% MET FILM
R199	RN55-21000	1	91637	RN55C1002F	10 K OHMS 1% MET FILM
R214	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R225	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R226	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R228	RN55-00475	1	91637	RN55C47R5F	47.5 OHMS 1% MET FILM
R229	RN55-00475	1	91637	RN55C47R5F	47.5 OHMS 1% MET FILM
R232	RN55-00475	1	91637	RN55C47R5F	47.5 OHMS 1% MET FILM
R233	RN55-00475	1	91637	RN55C47R5F	47.5 OHMS 1% MET FILM
R234	RN55-00475	1	91637	RN55C47R5F	47.5 OHMS 1% MET FILM
R235	RN55-00475	1	91637	RN55C47R5F	47.5 OHMS 1% MET FILM
R236	RK45-32490	1	59124	RN73K2A2493F	249K OHM 1% FILM SMT
R240	RN55-00475	1	91637	RN55C47R5F	47.5 OHMS 1% MET FILM
R241	RN55-00475	1	91637	RN55C47R5F	47.5 OHMS 1% MET FILM
R242	RN55-00475	1	91637	RN55C47R5F	47.5 OHMS 1% MET FILM
R243	RN55-00475	1	91637	RN55C47R5F	47.5 OHMS 1% MET FILM
R245	21445-011	1	——	RK73H2AT1002F	10.0K OHM 1% FILM SMT
R246	RN55-00475	1	91637	RN55C47R5F	47.5 OHMS 1% MET FILM
R247	RN55-00475	1	91637	RN55C47R5F	47.5 OHMS 1% MET FILM
R248	RN55-00475	1	91637	RN55C47R5F	47.5 OHMS 1% MET FILM
R249	RN55-00475	1	91637	RN55C47R5F	47.5 OHMS 1% MET FILM
R250	21445-011	1	——	RK73H2AT1002F	10.0K OHM 1% FILM SMT
R251	21445-011	1	——	RK73H2AT1002F	10.0K OHM 1% FILM SMT
R252	RN55-00475	1	91637	RN55C47R5F	47.5 OHMS 1% MET FILM
R253	RK45-23010	1	91637	CRCW08053012FT	30.1K OHM 1% FILM SMT
R254	RK45-23010	1	91637	CRCW08053012FT	30.1K OHM 1% FILM SMT
R255	21445-011	1	——	RK73H2AT1002F	10.0K OHM 1% FILM SMT
R256	21445-011	1	——	RK73H2AT1002F	10.0K OHM 1% FILM SMT
R257	RK45-12400	1	59124	RN73K2A2401F	2.4K OHM 1% FILM SMT
R258	21445-009	1	——	RK73H2AT4990F	499 OHM 1% FILM SMT
R261	RK45-09530	1	59124	RN73K2A9530F	953 OHM 1% FILM SMT
R263	RK45-05490	1	59124	RN73K2A5490F	549 OHM 1% FILM SMT
R264	RK45-05490	1	59124	RN73K2A5490F	549 OHM 1% FILM SMT
R269	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R270	RK45-00196	1	59124	RN73K2A19R6F	19.6 OHM 1% FILM SMT
R272	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R273	RW03-00390	1	91637	RS-2B-39-1	39 OHM 3W WIREWOUND
R274	RW03-00390	1	91637	RS-2B-39-1	39 OHM 3W WIREWOUND
RP1	14882-001	1	58900	14882-001	10K OHM X 9 SIP NETWORK
RP2	14882-001	1	58900	14882-001	10K OHM X 9 SIP NETWORK
RP3	14882-001	1	58900	14882-001	10K OHM X 9 SIP NETWORK
RT2	15208-001	1	56866	QT06002-022 Rev A	10 K OHM THERMISTOR
RT3	20607-002	1	06090	RXE050	.5A RES CIRCUIT BREAKER
RT4	20607-002	1	06090	RXE050	.5A RES CIRCUIT BREAKER

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Item	Part Number	Qty	Cage	Mfr's Part Number	Description
TP1	21456-001	1	58900	21456-001	BLACK TEST POINT
TP2	21456-001	1	58900	21456-001	BLACK TEST POINT
TP3	21456-001	1	58900	21456-001	BLACK TEST POINT
TP4	21456-001	1	58900	21456-001	BLACK TEST POINT
TP5	21456-001	1	58900	21456-001	BLACK TEST POINT
TP6	21456-001	1	58900	21456-001	BLACK TEST POINT
TP7	21456-001	1	58900	21456-001	BLACK TEST POINT
TP8	21456-001	1	58900	21456-001	BLACK TEST POINT
TP10	21456-001	1	58900	21456-001	BLACK TEST POINT
TP11	21456-001	1	58900	21456-001	BLACK TEST POINT
TP12	21456-001	1	58900	21456-001	BLACK TEST POINT
TP13	21456-001	1	58900	21456-001	BLACK TEST POINT
TP14	21456-001	1	58900	21456-001	BLACK TEST POINT
TP15	21456-001	1	58900	21456-001	BLACK TEST POINT
TP16	21456-001	1	58900	21456-001	BLACK TEST POINT
TP23	21456-001	1	58900	21456-001	BLACK TEST POINT
TP24	21456-001	1	58900	21456-001	BLACK TEST POINT
TP27	21456-001	1	58900	21456-001	BLACK TEST POINT
TP28	21456-001	1	58900	21456-001	BLACK TEST POINT
TP31	21456-001	1	58900	21456-001	BLACK TEST POINT
TP32	21456-001	1	58900	21456-001	BLACK TEST POINT
TP35	21456-001	1	58900	21456-001	BLACK TEST POINT
TP37	21456-001	1	58900	21456-001	BLACK TEST POINT
U1	15135	1	01295	OP-07/CP	HA5135-5 PRECISION OP AMP
U2	21189	1	17856	DG411DJ	DG411DJ QUAD SPST SWITCH
U3	15233	1	58900	15233	CA3240E DUAL OP AMP
U4	15135	1	01295	OP-07/CP	HA5135-5 PRECISION OP AMP
U5	ULN0-00393	1	01295	LM393P	LM393N VOLT COMPARATOR
U6	15093	1	64155	LM199H	LM399H 7V PRECISION ZENER
U7	15135	1	01295	OP-07/CP	HA5135-5 PRECISION OP AMP
U8	21189	1	17856	DG411DJ	DG411DJ QUAD SPST SWITCH
U9	UTN0-00322	1	01295	74HC32N	74HC32 QUAD 2 INPUT OR
U10	UTN0-00082	1	01295	SN74HC08N	74HC08N QUAD AND
U11	15135	1	01295	OP-07/CP	HA5135-5 PRECISION OP AMP
U12	15135	1	01295	OP-07/CP	HA5135-5 PRECISION OP AMP
U13	UIN0-07534	1	24355	AD7534JN	AD7534JN 14 BIT DAC
U14	19586	1	60395	X2444P	X2444P 256 BIT NV RAM
U15	UTN0-00042	1	01295	SN74HC04N	SN74HC04 HEX INVERTER
U16	13471	1	01295	LM324N	LM324AN QUAD OP AMP
U17	UID0-07245	1	24355	AD7245AAR	AD7245AAR 12 BIT DAC SMT
U18	21159	1	4T165	UPD71055C	uPD71055 PARALLEL INTERFACE
U19	13471	1	01295	LM324N	LM324AN QUAD OP AMP
U21	21159	1	4T165	UPD71055C	uPD71055 PARALLEL INTERFACE
U22	UID0-07891	1	24355	AD7891AP-2	AD7891AP-2 MUX/ADC SMT
U23	URD1-07805	1	04713	MC78L05ACD	MC78L05ACD .1A 5V REG
U24	UOD1-01007	1	64155	LT1007CS8	LT1007CS8 OP AMP
U25	UOD0-01356	1	64155	LT1356CS	LT1356CS QUAD OPAMP SMT
U26	UOD0-00436	1	62839	CLC436AJE	CLC436AJE OP AMP SMT
U27	UOD1-01007	1	64155	LT1007CS8	LT1007CS8 OP AMP
U28	ULD0-00613	1	17856	DG613DY	DG613DY 4PST SWITCH SMT
U29	UOD0-00426	1	62839	CLC426AJE	CLC426AJE OP AMP,SMT
U31	ULD0-00409	1	17856	DG409DY	DG409DY 2X 4IN SWITCH SMT
U33	URD1-07812	1	04713	MC78M12CDT	MC78M12CDT .5A 12V REG
U34	URD0-07912	1	01295	MC79L12ACD	MC79L12ACD .1A 12V SMT
U35	URD0-07812	1	04713	MC78L12ACD	MC78L12ACD .1A 12V SMT
U36	ULD0-00642	1	17856	DG642DY	DG642DY SPDT SWITCH SMT
U37	UID0-07245	1	24355	AD7245AAR	AD7245AAR 12 BIT DAC SMT
U38	17714	1	01295	LM358AP	LM358AN DUAL OP AMP
U39	UOD0-00324	1	04713	LM324D	LM324D QUAD OP AMP SMT
U40	URD1-07912	1	01295	UA78M45CKTP	MC79M12CDT .5A -12V REG
U41	UTD0-00143	1	04713	MC74HCT14AD	74HCT14D HEX SCHMITT INV SMT
U44	ULD0-00643	1	17856	DG643DY	DG643DY 2PDT SWITCH SMT
U45	UOD0-00111	1	62839	CLC111AJE	CLC111AJE BUFFER,SMT

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Item	Part Number	Qty	Cage	Mfr's Part Number	Description
U46	UOD0-00111	1	62839	CLC111AJE	CLC111AJE BUFFER,SMT
U47	ULD0-00643	1	17856	DG643DY	DG643DY 2PDT SWITCH SMT
U48	UOD0-00426	1	62839	CLC426AJE	CLC426AJE OP AMP,SMT
U52	UOD0-00428	1	62839	CLC428JE	CLC428AJE OP AMP SMT
U54	UOD0-01356	1	64155	LT1356CS	LT1356CS QUAD OPAMP SMT
U56	ULD0-00643	1	17856	DG643DY	DG643DY 2PDT SWITCH SMT
U57	URD0-07905	1	04713	MC79M05CDT	MC79MO5CDT .5A -5V SMT
U58	URD0-07805	1	04713	MC78M05CDT	MC78M05CDT.5A 5V REG SM
U59	UOD0-00428	1	62839	CLC428JE	CLC428AJE OP AMP SMT
U62	ULD0-00643	1	17856	DG643DY	DG643DY 2PDT SWITCH SMT
U64	ULD0-00643	1	17856	DG643DY	DG643DY 2PDT SWITCH SMT
U90	ULD0-00642	1	17856	DG642DY	DG642DY SPDT SWITCH SMT
U91	UID0-01410	1	64155	LTC1410CS	LTC1410CS 12 BIT A/D SMT
U104	30619	1	58900	30619	PROG GAL 854XC A2 U104
U105	30621	1	58900	30621	PROG GAL 854XC A2 U105
U106	30623	1	58900	30623	PROG GAL 854XC A2 U106
U107	UTD0-00742	1	01295	SN74HC74D	74HC74D DUAL D FFLOP SMT
U108	UTD0-00742	1	01295	SN74HC74D	74HC74D DUAL D FFLOP SMT
U109	UTD0-00742	1	01295	SN74HC74D	74HC74D DUAL D FFLOP SMT
U110	UTD0-40402	1	01295	74HC4040D	74HC4040D 12 BIT CT SMT
U111	30625	1	58900	30625	PROG EPROM 854XC A2 U111
U112	UGD0-09501	1	24355	AD9501JP	AD9501JP DELAY GEN SMT
U113	UTD0-00143	1	04713	MC74HCT14AD	74HCT14D HEX SCHMITT INV SMT
W1	JIA1-03230	1	58900	JIA1-03230	3 PIN STRIPLINE PLUG
XQ4	11037	1	13103	7717-22-N	TO5 NYLON INSULATOR
XW1	17240-001	1	27264	15-38-1024	JUMPER,INSULATED,2 POS

30173 8542C ANALOG PC ASSY (A2), Rev: L

Item	Part Number	Qty	Cage	Mfr's Part Number	Description
1	11438	6	——	SP5303-GRAY	MOLDED BUMPER
2	20192	1	58900	20192	SHELL,OBLONG
3	20259	1	58900	20259	COVER,CALIBRATOR HOUSING
4	20260	1	58900	20260	HOUSING,CALIBRATOR
5	20800	1	58900	20800	LABEL,US PATENT 4,794,325
7	21210	4	58900	21210	PLASTIC LATCH GROMMET
8	21211	4	58900	21211	PLASTIC LATCH PLUNGER
9	HBPP-44004	12	26233	NS137CR440R4	4-40 X 1/4 PAN
10	HWSS-40300	12	58900	HWSS-40300	#4 X 3/16 SPLIT LOCK
11	10479	1	——	4504-3/4"	3/4 X 1/4 FOAM TAPE
12	30163	1	58900	30163	8540C ANALOG PCB
13	30165	REF	58900	30165	8540C ANALOG P.C.B. SCH.
14	PH00-00001	2	4J674	44-CBS-1.5X5.5X.4	SHIELD COVER
15	30166	REF	58900	30166	8540C ANALOG P.C.B. TEST PLAN
16	WTT0-22001	0	16428	#22AWG-TFE/TW	#22 CLEAR TFE SLVNG
A1	20112	1	58900	20112	CALIB THERM OVEN PCB ASSY
C1	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C2	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C3	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C4	21627-001	1	04222	TAJD106M025R	10 UF 25V TANTALUM SMT
C5	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C6	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C7	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C8	21627-001	1	04222	TAJD106M025R	10 UF 25V TANTALUM SMT
C9	21627-001	1	04222	TAJD106M025R	10 UF 25V TANTALUM SMT
C10	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C11	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C14	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C15	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C16	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C17	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C18	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C19	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C20	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C21	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C22	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C23	CK51-05220	1	58900	CK51-05220	2.2 UF Y5V CHIP CERAMIC
C24	CK51-05220	1	58900	CK51-05220	2.2 UF Y5V CHIP CERAMIC
C25	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C26	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C27	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C28	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C29	21627-001	1	04222	TAJD106M025R	10 UF 25V TANTALUM SMT
C30	21627-001	1	04222	TAJD106M025R	10 UF 25V TANTALUM SMT
C31	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C32	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C33	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C34	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C35	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C36	10001-005	1	——	CCD-330	33 PF 1KV CERAMIC NPO
C37	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C38	CC50-04220	1	31433	C322C224M5U5CA	.22 UF CERAMIC Z5U
C39	20032-001	1	58900	20032-001	.47UF 100V POLYPROPYLENE
C40	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C41	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C42	CE50-R5470	1	55680	USA1H4R7MCA	4.7UF 50V RADIAL
C43	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C44	CE50-R5470	1	55680	USA1H4R7MCA	4.7UF 50V RADIAL
C45	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C46	CE50-R5470	1	55680	USA1H4R7MCA	4.7UF 50V RADIAL
C47	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C48	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C49	CC50-02220	1	04222	SR155C222KAA	2200PF CERAMIC X7R

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Item	Part Number	Qty	Cage	Mfr's Part Number	Description
C50	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C51	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C52	10909-013	1	——-	DM15-151F	150 PF DIP MICA
C53	10909-018	1	——-	DM15-241F	240 PF DIP MICA
C54	CC50-02220	1	04222	SR155C222KAA	2200PF CERAMIC X7R
C55	10909-011	1	——-	CMO5FD620F03	62 PF DIP MICA
C56	10909-012	1	——-	CMO6FD121J03	120 PF DIP MICA
C57	10909-011	1	——-	CMO5FD620F03	62 PF DIP MICA
C58	10677-018	1	——-	CM05E102	1000 PF DIP MICA
C59	CC50-02220	1	04222	SR155C222KAA	2200PF CERAMIC X7R
C60	CC50-02220	1	04222	SR155C222KAA	2200PF CERAMIC X7R
C61	15640-012	1	04222	SR201A222KAA	2200 PF CERAMIC COG
C62	15640-012	1	04222	SR201A222KAA	2200 PF CERAMIC COG
C63	10677-018	1	——-	CM05E102	1000 PF DIP MICA
C64	CC50-01100	1	04222	SR151A101JAA	100 PF CERAMIC NPO
C65	CC50-01100	1	04222	SR151A101JAA	100 PF CERAMIC NPO
C66	CC50-01100	1	04222	SR151A101JAA	100 PF CERAMIC NPO
C67	15640-012	1	04222	SR201A222KAA	2200 PF CERAMIC COG
C68	15640-012	1	04222	SR201A222KAA	2200 PF CERAMIC COG
C69	15640-012	1	04222	SR201A222KAA	2200 PF CERAMIC COG
C70	15640-012	1	04222	SR201A222KAA	2200 PF CERAMIC COG
C71	CC50-02470	1	31433	C315C472K1R5CA	4700 PF CERAMIC X7R
C72	CC50-01100	1	04222	SR151A101JAA	100 PF CERAMIC NPO
C73	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C74	CC50-02470	1	31433	C315C472K1R5CA	4700 PF CERAMIC X7R
C75	CC50-04220	1	31433	C322C224M5U5CA	.22 UF CERAMIC Z5U
C77	CC50-02220	1	04222	SR155C222KAA	2200PF CERAMIC X7R
C78	CC50-02100	1	04222	SR155C122MAT	.001 UF CERAMIC Y5P
C79	CC50-01100	1	04222	SR151A101JAA	100 PF CERAMIC NPO
C80	CC50-02220	1	04222	SR155C222KAA	2200PF CERAMIC X7R
C81	CC50-02220	1	04222	SR155C222KAA	2200PF CERAMIC X7R
C82	CC50-02220	1	04222	SR155C222KAA	2200PF CERAMIC X7R
C83	CC50-02220	1	04222	SR155C222KAA	2200PF CERAMIC X7R
C84	CC50-03470	1	31433	C320C473K5R5CA	.047 UF CERAMIC X7R
C85	CC50-02220	1	04222	SR155C222KAA	2200PF CERAMIC X7R
C86	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C87	CC50-02100	1	04222	SR155C122MAT	.001 UF CERAMIC Y5P
C88	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C89	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C90	CK50-00100	1	54583	CC0805HNPO15150J	10 PF NPO CHIP
C91	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C92	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C93	CK50-00100	1	54583	CC0805HNPO15150J	10 PF NPO CHIP
C94	CK51-05220	1	58900	CK51-05220	2.2 UF Y5V CHIP CERAMIC
C95	CK51-05220	1	58900	CK51-05220	2.2 UF Y5V CHIP CERAMIC
C96	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C97	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C98	CK51-05220	1	58900	CK51-05220	2.2 UF Y5V CHIP CERAMIC
C99	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C100	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C101	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C102	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C103	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C104	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C105	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C106	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C107	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C108	CK51-02100	1	04222	08055C102KATMA	1000PF X7R CHIP CERAMIC
C109	CK51-05220	1	58900	CK51-05220	2.2 UF Y5V CHIP CERAMIC
C110	21627-001	1	04222	TAJD106M025R	10 UF 25V TANTALUM SMT
C111	21627-001	1	04222	TAJD106M025R	10 UF 25V TANTALUM SMT
C113	CK51-05220	1	58900	CK51-05220	2.2 UF Y5V CHIP CERAMIC
C114	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC

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Item	Part Number	Qty	Cage	Mfr's Part Number	Description
C115	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C116	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C117	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C118	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C119	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C120	CK51-05220	1	58900	CK51-05220	2.2 UF Y5V CHIP CERAMIC
C121	CK50-00100	1	54583	CC0805HNPO15150J	10 PF NPO CHIP
C122	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C123	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C124	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C125	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C126	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C127	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C128	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C129	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C130	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C131	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C132	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C133	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C134	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C135	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C136	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C137	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C138	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C139	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C140	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C141	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C142	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C143	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C144	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C145	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C146	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C147	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C148	CK50-03100	1	31433	C0805C103K5RAC	.01 UF X7R CHIP
C149	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C150	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C151	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C152	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C153	21627-001	1	04222	TAJD106M025R	10 UF 25V TANTALUM SMT
C154	CC50-03100	1	54583	RD30HX7R103K	.01 UF CERAMIC X7R
C155	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C156	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C157	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C158	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C159	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C160	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C161	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C162	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C163	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C164	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C165	15776-005	1	04222	SR205C-104KAA	.1 UF CERAMIC X7R
C166	CE50-R6100	1	55680	UVX1H100MDA	10 UF 50V RADIAL LEAD
C167	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C168	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C169	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C170	CK50-00100	1	54583	CC0805HNPO15150J	10 PF NPO CHIP
C171	21627-001	1	04222	TAJD106M025R	10 UF 25V TANTALUM SMT
C172	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C173	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C174	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C175	21627-001	1	04222	TAJD106M025R	10 UF 25V TANTALUM SMT
C176	21627-001	1	04222	TAJD106M025R	10 UF 25V TANTALUM SMT
C177	CC50-04220	1	31433	C322C224M5U5CA	.22 UF CERAMIC Z5U

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Item	Part Number	Qty	Cage	Mfr's Part Number	Description
C178	CK51-02100	1	04222	08055C102KATMA	1000PF X7R CHIP CERAMIC
C179	CK51-05220	1	58900	CK51-05220	2.2 UF Y5V CHIP CERAMIC
C180	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C181	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C182	CK51-05220	1	58900	CK51-05220	2.2 UF Y5V CHIP CERAMIC
C183	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C184	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C185	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C186	CK51-02100	1	04222	08055C102KATMA	1000PF X7R CHIP CERAMIC
C187	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C188	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C189	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C190	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C191	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C192	CK51-05220	1	58900	CK51-05220	2.2 UF Y5V CHIP CERAMIC
C193	21627-001	1	04222	TAJD106M025R	10 UF 25V TANTALUM SMT
C194	21627-001	1	04222	TAJD106M025R	10 UF 25V TANTALUM SMT
C195	CK51-05220	1	58900	CK51-05220	2.2 UF Y5V CHIP CERAMIC
C196	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C197	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C198	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C199	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C200	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C201	CK51-02100	1	04222	08055C102KATMA	1000PF X7R CHIP CERAMIC
C202	21627-001	1	04222	TAJD106M025R	10 UF 25V TANTALUM SMT
C203	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C204	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C205	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C206	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C207	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C208	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C209	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C210	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C211	21627-001	1	04222	TAJD106M025R	10 UF 25V TANTALUM SMT
C212	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C215	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C216	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C217	21627-001	1	04222	TAJD106M025R	10 UF 25V TANTALUM SMT
C218	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C219	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C220	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C222	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C223	21627-001	1	04222	TAJD106M025R	10 UF 25V TANTALUM SMT
C224	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C225	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C226	21627-001	1	04222	TAJD106M025R	10 UF 25V TANTALUM SMT
C227	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C228	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C229	CK50-01100	1	58900	CK50-01100	100 PF CERAMIC NPO
C230	CK50-03100	1	31433	C0805C103K5RAC	.01 UF X7R CHIP
C231	CK50-01470	1	58900	CK50-01470	470PF COG CHIP CERAMIC
C232	CK50-03100	1	31433	C0805C103K5RAC	.01 UF X7R CHIP
C233	CK50-03100	1	31433	C0805C103K5RAC	.01 UF X7R CHIP
C234	CK50-03100	1	31433	C0805C103K5RAC	.01 UF X7R CHIP
C235	CK50-03100	1	31433	C0805C103K5RAC	.01 UF X7R CHIP
C236	CK50-03100	1	31433	C0805C103K5RAC	.01 UF X7R CHIP
C237	CK50-03100	1	31433	C0805C103K5RAC	.01 UF X7R CHIP
C238	CK50-03100	1	31433	C0805C103K5RAC	.01 UF X7R CHIP
C239	CK50-03100	1	31433	C0805C103K5RAC	.01 UF X7R CHIP
C240	CK50-03100	1	31433	C0805C103K5RAC	.01 UF X7R CHIP
C241	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C242	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C243	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC

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Item	Part Number	Qty	Cage	Mfr's Part Number	Description
C244	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C245	CK50-03470	1	90201	0805B473K500NT	.047 UF X7R CHIP CERAMIC
C246	CK50-01470	1	58900	CK50-01470	470PF COG CHIP CERAMIC
C247	CK50-01470	1	58900	CK50-01470	470PF COG CHIP CERAMIC
C248	CK50-01470	1	58900	CK50-01470	470PF COG CHIP CERAMIC
CR2	DSA0-04148	1	58900	DSA0-04148	1N4148 G.P. DIODE
CR3	DSA0-04148	1	58900	DSA0-04148	1N4148 G.P. DIODE
CR4	DSA0-04148	1	58900	DSA0-04148	1N4148 G.P. DIODE
CR5	DSA0-04148	1	58900	DSA0-04148	1N4148 G.P. DIODE
CR6	DSA0-04148	1	58900	DSA0-04148	1N4148 G.P. DIODE
CR7	DSA0-04148	1	58900	DSA0-04148	1N4148 G.P. DIODE
CR8	13618	1	58900	13618	DIODE,uWAVE PIN SW,.3PF,100ns
CR9	13618	1	58900	13618	DIODE,uWAVE PIN SW,.3PF,100ns
CR10	13618	1	58900	13618	DIODE,uWAVE PIN SW,.3PF,100ns
CR11	13618	1	58900	13618	DIODE,uWAVE PIN SW,.3PF,100ns
CR12	13618	1	58900	13618	DIODE,uWAVE PIN SW,.3PF,100ns
CR13	13618	1	58900	13618	DIODE,uWAVE PIN SW,.3PF,100ns
CR14	13618	1	58900	13618	DIODE,uWAVE PIN SW,.3PF,100ns
CR15	DSA0-04148	1	58900	DSA0-04148	1N4148 G.P. DIODE
CR16	DSA2-00099	1	58900	DSA2-00099	BAV99;DUAL,DIODE;SMT
CR17	DSA2-00099	1	58900	DSA2-00099	BAV99;DUAL,DIODE;SMT
CR18	DSA2-00099	1	58900	DSA2-00099	BAV99;DUAL,DIODE;SMT
CR19	DSA2-00099	1	58900	DSA2-00099	BAV99;DUAL,DIODE;SMT
CR20	DZAB-00751	1	04713	1N751A	1N751A 5.1V ZENER
J1	19941-001	1	09769	102975-7	14 PIN STRIPLINE PLUG
J2	19941-001	1	09769	102975-7	14 PIN STRIPLINE PLUG
J3	21164	1	09769	413524-1	BNC F RT ANG PC MOUNT
J4	21164	1	09769	413524-1	BNC F RT ANG PC MOUNT
J5	JRBM-00100	1	58900	JRBM-00100	SMB M PC MOUNT
L11	10631-010	1	58900	10631-010	6.8 UH INDUCTOR
L12	19203	1	OB3G8	19203	.1 UH RF COIL
L13	15293	1	58900	15293	.17 UH INDUCTOR
L14	15293	1	58900	15293	.17 UH INDUCTOR
L15	15293	1	58900	15293	.17 UH INDUCTOR
L16	10631-010	1	58900	10631-010	6.8 UH INDUCTOR
L17	10631-010	1	58900	10631-010	6.8 UH INDUCTOR
L18	10631-010	1	58900	10631-010	6.8 UH INDUCTOR
P1	16570	1	09769	2-87227-5	50 PIN STRIPLINE PLUG
Q1	QBPP-00170	1	04713	MJE 170	MJE 170 3A 40V 12.5W PNP
Q2	QBNS-03904	1	04713	2N3904	2N3904 .2A 40V NPN
Q3	QBNS-03904	1	04713	2N3904	2N3904 .2A 40V NPN
Q4	20242	1	01295	2N3553	2N3553 2.5W 175 MHZ NPN
Q5	10023	1	58900	10023	2N3644 .3 A 45 V PNP
Q6	10017	1	4U751	2N3569	PN3569 .5A 40V NPN
Q7	10017	1	4U751	2N3569	PN3569 .5A 40V NPN
Q8	20850	1	04713	MMBT3904L	TRANSISTOR NPN 3904 (SOT-23)
Q9	QJNS-04416	1	04713	MMBF4416L	MMBF4416L FET AMP SMT
Q10	QJNS-04416	1	04713	MMBF4416L	MMBF4416L FET AMP SMT
Q11	QJNS-04416	1	04713	MMBF4416L	MMBF4416L FET AMP SMT
Q12	QJNS-04416	1	04713	MMBF4416L	MMBF4416L FET AMP SMT
Q13	QJNS-04416	1	04713	MMBF4416L	MMBF4416L FET AMP SMT
Q14	QJNS-04416	1	04713	MMBF4416L	MMBF4416L FET AMP SMT
Q15	QJNS-04416	1	04713	MMBF4416L	MMBF4416L FET AMP SMT
Q16	QJNS-04416	1	04713	MMBF4416L	MMBF4416L FET AMP SMT
Q17	QJNS-04416	1	04713	MMBF4416L	MMBF4416L FET AMP SMT
Q18	QJNS-04416	1	04713	MMBF4416L	MMBF4416L FET AMP SMT
Q19	QJNS-04416	1	04713	MMBF4416L	MMBF4416L FET AMP SMT
Q20	QJNS-04416	1	04713	MMBF4416L	MMBF4416L FET AMP SMT
Q21	QJNS-04416	1	04713	MMBF4416L	MMBF4416L FET AMP SMT
Q22	QJNS-04416	1	04713	MMBF4416L	MMBF4416L FET AMP SMT
Q23	QJNS-04416	1	04713	MMBF4416L	MMBF4416L FET AMP SMT
Q24	QJNS-04416	1	04713	MMBF4416L	MMBF4416L FET AMP SMT
R1	RK45-13320	1	91637	CRCW08053321FT	3.32K OHM 1% FILM SMT

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Item	Part Number	Qty	Cage	Mfr's Part Number	Description
R2	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R3	RK45-05490	1	59124	RN73K2A5490F	549 OHM 1% FILM SMT
R4	RK45-01800	1	59124	RN73K2A1800F	180 OHM 1% FILM SMT
R5	RK45-03160	1	59124	RN73K2A3160F	316 OHM 1% FILM SMT
R6	RK45-01800	1	59124	RN73K2A1800F	180 OHM 1% FILM SMT
R7	RK45-01800	1	59124	RN73K2A1800F	180 OHM 1% FILM SMT
R8	RK45-01800	1	59124	RN73K2A1800F	180 OHM 1% FILM SMT
R9	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R10	RK45-01800	1	59124	RN73K2A1800F	180 OHM 1% FILM SMT
R11	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R12	RK45-05490	1	59124	RN73K2A5490F	549 OHM 1% FILM SMT
R13	RK45-03160	1	59124	RN73K2A3160F	316 OHM 1% FILM SMT
R14	RK45-01800	1	59124	RN73K2A1800F	180 OHM 1% FILM SMT
R15	RK45-01800	1	59124	RN73K2A1800F	180 OHM 1% FILM SMT
R16	RK45-01800	1	59124	RN73K2A1800F	180 OHM 1% FILM SMT
R17	RK45-31470	1	91637	CRCW08051473FT	147K OHM 1% FILM SMT
R18	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R19	RK45-02870	1	58900	RK45-02870	287 OHM 1% FILM SMT
R20	RK45-32490	1	59124	RN73K2A2493F	249K OHM 1% FILM SMT
R21	RK45-21470	1	58900	RK45-21470	14.7K OHM 1% FILM SMT
R22	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R23	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R24	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R25	RK45-00681	1	59124	RN73K2A68R1F	68.1 OHM 1% FILM SMT
R26	RK45-00681	1	59124	RN73K2A68R1F	68.1 OHM 1% FILM SMT
R27	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R28	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R29	RK45-13320	1	91637	CRCW08053321FT	3.32K OHM 1% FILM SMT
R30	RN55-11000	1	91637	RN55C1001F	1 K OHMS 1% MET FILM
R31	RN55-03320	1	91637	RN55C3320F	332 OHMS 1% MET FILM
R32	RN55-03320	1	91637	RN55C3320F	332 OHMS 1% MET FILM
R33	RN55-11820	1	91637	RN55C1821F	1.82 K OHMS 1% MET FILM
R34	21445-002	1	——-	RK73H2AT1003F	100K OHM 1% FILM SMT
R35	RN55-14750	1	91637	RN55C4751F	4.75 K OHMS 1% MET FILM
R36	RK45-05490	1	59124	RN73K2A5490F	549 OHM 1% FILM SMT
R37	RK45-32490	1	59124	RN73K2A2493F	249K OHM 1% FILM SMT
R38	RK45-14420	1	58900	RK45-14420	4.42K OHM 1% FILM SMT
R39	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R40	RK45-32490	1	59124	RN73K2A2493F	249K OHM 1% FILM SMT
R41	RK45-32490	1	59124	RN73K2A2493F	249K OHM 1% FILM SMT
R42	RK45-13320	1	91637	CRCW08053321FT	3.32K OHM 1% FILM SMT
R43	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R44	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R45	RK45-13320	1	91637	CRCW08053321FT	3.32K OHM 1% FILM SMT
R46	RK45-22670	1	58900	RK45-22670	26.7K OHM 1% FILM SMT
R47	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R48	21445-009	1	——-	RK73H2AT4990F	499 OHM 1% FILM SMT
R49	21445-009	1	——-	RK73H2AT4990F	499 OHM 1% FILM SMT
R50	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R51	RK45-23010	1	91637	CRCW08053012FT	30.1K OHM 1% FILM SMT
R52	21445-011	1	——	RK73H2AT1002F	10.0K OHM 1% FILM SMT
R53	RK45-23010	1	91637	CRCW08053012FT	30.1K OHM 1% FILM SMT
R54	21445-009	1	——-	RK73H2AT4990F	499 OHM 1% FILM SMT
R55	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R56	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R57	RK45-03160	1	59124	RN73K2A3160F	316 OHM 1% FILM SMT
R58	RK45-00681	1	59124	RN73K2A68R1F	68.1 OHM 1% FILM SMT
R59	RK45-23010	1	91637	CRCW08053012FT	30.1K OHM 1% FILM SMT
R60	RK45-00681	1	59124	RN73K2A68R1F	68.1 OHM 1% FILM SMT
R61	RK45-00196	1	59124	RN73K2A19R6F	19.6 OHM 1% FILM SMT
R62	21445-011	1	——	RK73H2AT1002F	10.0K OHM 1% FILM SMT
R63	RK45-00412	1	58900	RK45-00412	41.2 OHM 1% FILM SMT
R64	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT

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Item	Part Number	Qty	Cage	Mfr's Part Number	Description
R65	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R66	21445-009	1	——	RK73H2AT4990F	499 OHM 1% FILM SMT
R67	21445-009	1	——	RK73H2AT4990F	499 OHM 1% FILM SMT
R68	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R69	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R70	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R71	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R72	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R73	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R74	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R75	21445-009	1	——	RK73H2AT4990F	499 OHM 1% FILM SMT
R76	21445-009	1	——	RK73H2AT4990F	499 OHM 1% FILM SMT
R77	21445-011	1	——	RK73H2AT1002F	10.0K OHM 1% FILM SMT
R78	21445-011	1	——	RK73H2AT1002F	10.0K OHM 1% FILM SMT
R85	RK45-01800	1	59124	RN73K2A1800F	180 OHM 1% FILM SMT
R86	RK45-01800	1	59124	RN73K2A1800F	180 OHM 1% FILM SMT
R87	RK45-32490	1	59124	RN73K2A2493F	249K OHM 1% FILM SMT
R88	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R89	RK45-01800	1	59124	RN73K2A1800F	180 OHM 1% FILM SMT
R90	RK45-32490	1	59124	RN73K2A2493F	249K OHM 1% FILM SMT
R91	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R92	RK45-14420	1	58900	RK45-14420	4.42K OHM 1% FILM SMT
R93	RK45-05490	1	59124	RN73K2A5490F	549 OHM 1% FILM SMT
R94	RK45-01800	1	59124	RN73K2A1800F	180 OHM 1% FILM SMT
R95	RK45-01800	1	59124	RN73K2A1800F	180 OHM 1% FILM SMT
R96	21445-002	1	——	RK73H2AT1003F	100K OHM 1% FILM SMT
R97	RN55-11820	1	91637	RN55C1821F	1.82 K OHMS 1% MET FILM
R98	RN55-14750	1	91637	RN55C4751F	4.75 K OHMS 1% MET FILM
R99	RN55-00274	1	91637	RN55C27R4F	27.4 OHMS 1% MET FILM
R100	12449-053	1	58900	12449-053	50.0 K OHM .1 % MET FILM
R101	12449-053	1	58900	12449-053	50.0 K OHM .1 % MET FILM
R102	12449-053	1	58900	12449-053	50.0 K OHM .1 % MET FILM
R103	12449-053	1	58900	12449-053	50.0 K OHM .1 % MET FILM
R104	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R105	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R106	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R107	RN55-21000	1	91637	RN55C1002F	10 K OHMS 1% MET FILM
R108	RN55-03920	1	91637	RN55C3920F	392 OHMS 1% MET FILM
R109	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R110	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R111	RK45-05490	1	59124	RN73K2A5490F	549 OHM 1% FILM SMT
R112	RK45-21470	1	58900	RK45-21470	14.7K OHM 1% FILM SMT
R113	RN55-24750	1	91637	RN55C4752F	47.5 K OHMS 1% MET FILM
R114	RN55-11000	1	91637	RN55C1001F	1 K OHMS 1% MET FILM
R115	10015-064	1	91637	RN55D 1.13K OHM 1%	1.13 K OHMS 1% MET FILM
R117	12449-048	1	58900	12449-048	15.0 K OHM .1 % MET FILM
R118	12449-032	1	58900	12449-032	1.25 K OHM .1% MET FILM
R119	12449-028	1	58900	12449-028	12.5 K OHM .1% MET FILM
R120	RN55-21000	1	91637	RN55C1002F	10 K OHMS 1% MET FILM
R121	RN55-41000	1	91637	RN55C1004F	1 M OHMS 1% MET FILM
R122	RN55-14750	1	91637	RN55C4751F	4.75 K OHMS 1% MET FILM
R123	RN55-21000	1	91637	RN55C1002F	10 K OHMS 1% MET FILM
R124	RN55-14750	1	91637	RN55C4751F	4.75 K OHMS 1% MET FILM
R125	RN55-14750	1	91637	RN55C4751F	4.75 K OHMS 1% MET FILM
R126	12449-128	1	58900	12449-128	13.33 K OHM .1 % MET FILM
R127	12449-129	1	58900	12449-129	40.0 K OHM .1 % MET FILM
R128	RN55-12210	1	91637	RN55C2211F	2.21 K OHMS 1% MET FILM
R129	RK45-31470	1	91637	CRCW08051473FT	147K OHM 1% FILM SMT
R130	RK45-22670	1	58900	RK45-22670	26.7K OHM 1% FILM SMT
R131	RN55-12000	1	91637	RN55C2001F	2.00 K OHMS 1% MET FILM
R132	RN55-12000	1	91637	RN55C2001F	2.00 K OHMS 1% MET FILM
R133	RN55-11000	1	91637	RN55C1001F	1 K OHMS 1% MET FILM
R134	RN55-13010	1	91637	RN55C3011F	3.01 K OHMS 1% MET FILM

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Item	Part Number	Qty	Cage	Mfr's Part Number	Description
R135	RN55-22210	1	91637	RN55C2212F	22.1 K OHMS 1% MET FILM
R136	RN55-23160	1	91637	RN55C3162F	31.6 K OHMS 1% MET FILM
R137	RN55-21330	1	91637	RN55C1332F	13.3 K OHMS 1% MET FILM
R138	RK45-13320	1	91637	CRCW08053321FT	3.32K OHM 1% FILM SMT
R139	RN55-11000	1	91637	RN55C1001F	1 K OHMS 1% MET FILM
R140	RN55-14990	1	91637	RN55C4991F	4.99 K OHMS 1% MET FILM
R141	12449-090	1	58900	12449-090	8.00 K OHM .1 % MET FILM
R142	RN55-21000	1	91637	RN55C1002F	10 K OHMS 1% MET FILM
R143	RN55-21000	1	91637	RN55C1002F	10 K OHMS 1% MET FILM
R144	RN55-00274	1	91637	RN55C27R4F	27.4 OHMS 1% MET FILM
R145	RK45-02870	1	58900	RK45-02870	287 OHM 1% FILM SMT
R146	RN55-12490	1	91637	RN55C2491F	2.49 K OHMS 1% MET FILM
R147	RN55-12490	1	91637	RN55C2491F	2.49 K OHMS 1% MET FILM
R148	RN55-21210	1	91637	RN55C1212F	12.1 K OHMS 1% MET FILM
R149	RN55-21000	1	91637	RN55C1002F	10 K OHMS 1% MET FILM
R150	RN55-03740	1	91637	RN55C3740F	374 OHMS 1% MET FILM
R151	RN55-03740	1	91637	RN55C3740F	374 OHMS 1% MET FILM
R152	RN55-11000	1	91637	RN55C1001F	1 K OHMS 1% MET FILM
R153	RN55-11000	1	91637	RN55C1001F	1 K OHMS 1% MET FILM
R154	RN55-11000	1	91637	RN55C1001F	1 K OHMS 1% MET FILM
R155	RN55-04990	1	91637	RN55C4990F	499 OHMS 1% MET FILM
R156	RN55-04990	1	91637	RN55C4990F	499 OHMS 1% MET FILM
R157	10015-082	1	91637	CCF55-2-61.9^1%T2T/R	61.9 OHMS 1% MET FILM
R158	10015-144	1	91637	RN55D 95.3 OHM 1%	95.3 OHM 1% MET FILM
R159	10015-144	1	91637	RN55D 95.3 OHM 1%	95.3 OHM 1% MET FILM
R160	RN55-11500	1	91637	RN55C1501F	1.5 K OHMS 1% MET FILM
R161	RN55-11000	1	91637	RN55C1001F	1 K OHMS 1% MET FILM
R162	10015-125	1	91637	CCF55-2-28.7^1%T2T/R	28.7 OHMS 1% MET FILM
R163	RN55-00110	1	91637	RN55C11R0F	11.0 OHMS 1% MET FILM
R164	RN55-11000	1	91637	RN55C1001F	1 K OHMS 1% MET FILM
R165	RN55-04990	1	91637	RN55C4990F	499 OHMS 1% MET FILM
R166	10015-082	1	91637	CCF55-2-61.9^1%T2T/R	61.9 OHMS 1% MET FILM
R167	RN55-02430	1	91637	RN55C2430F	243 OHMS 1% MET FILM
R168	RN55-11000	1	91637	RN55C1001F	1 K OHMS 1% MET FILM
R169	RN55-04990	1	91637	RN55C4990F	499 OHMS 1% MET FILM
R170	10015-082	1	91637	CCF55-2-61.9^1%T2T/R	61.9 OHMS 1% MET FILM
R171	RN55-23010	1	91637	RN55C3012F	30.1 K OHMS 1% MET FILM
R172	RN55-31100	1	91637	RN55C1103F	110 K OHMS 1% MET FILM
R173	RN55-12740	1	91637	RN55C2741F	2.74K OHMS 1% MET FILM
R174	11845-004	1	91637	FP215R0 5%	15 OHM 10% METAL GLAZE
R175	RN55-11500	1	91637	RN55C1501F	1.5 K OHMS 1% MET FILM
R176	RN55-21000	1	91637	RN55C1002F	10 K OHMS 1% MET FILM
R177	RN55-21000	1	91637	RN55C1002F	10 K OHMS 1% MET FILM
R178	RN55-21000	1	91637	RN55C1002F	10 K OHMS 1% MET FILM
R179	RN55-22210	1	91637	RN55C2212F	22.1 K OHMS 1% MET FILM
R180	RN55-21500	1	91637	RN55C1502F	15 K OHMS 1% MET FILM
R181	RN55-14750	1	91637	RN55C4751F	4.75 K OHMS 1% MET FILM
R182	RN55-14750	1	91637	RN55C4751F	4.75 K OHMS 1% MET FILM
R183	RN55-02490	1	91637	RN55C2490F	249 OHMS 1% MET FILM
R184	RN55-34750	1	91637	RN55C4753F	475 K OHMS 1% MET FILM
R185	RN55-11000	1	91637	RN55C1001F	1 K OHMS 1% MET FILM
R186	RN55-12000	1	91637	RN55C2001F	2.00 K OHMS 1% MET FILM
R187	RN55-00100	1	91637	RN55C10R0F	10 OHMS 1% MET FILM
R188	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R189	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R190	RK45-00576	1	59124	RN73K2A57R6F	57.6 OHM 1% FILM SMT
R191	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R192	RK45-01800	1	59124	RN73K2A1800F	180 OHM 1% FILM SMT
R193	RK45-01800	1	59124	RN73K2A1800F	180 OHM 1% FILM SMT
R194	21445-011	1	——	RK73H2AT1002F	10.0K OHM 1% FILM SMT
R195	21445-011	1	——	RK73H2AT1002F	10.0K OHM 1% FILM SMT
R196	RK45-32490	1	59124	RN73K2A2493F	249K OHM 1% FILM SMT
R198	RN55-01000	1	91637	RN55C1000F	100 OHMS 1% MET FILM

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Item	Part Number	Qty	Cage	Mfr's Part Number	Description
R199	RN55-21000	1	91637	RN55C1002F	10 K OHMS 1% MET FILM
R200	RK45-32490	1	59124	RN73K2A2493F	249K OHM 1% FILM SMT
R201	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R202	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R203	RW03-00390	1	91637	RS-2B-39-1	39 OHM 3W WIREWOUND
R204	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R205	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R206	RK45-03160	1	59124	RN73K2A3160F	316 OHM 1% FILM SMT
R207	RK45-31470	1	91637	CRCW08051473FT	147K OHM 1% FILM SMT
R208	RK45-21470	1	58900	RK45-21470	14.7K OHM 1% FILM SMT
R209	RK45-22670	1	58900	RK45-22670	26.7K OHM 1% FILM SMT
R210	RK45-05490	1	59124	RN73K2A5490F	549 OHM 1% FILM SMT
R212	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R213	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R214	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R215	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R216	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R217	RK45-31470	1	91637	CRCW08051473FT	147K OHM 1% FILM SMT
R219	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R220	RK45-22670	1	58900	RK45-22670	26.7K OHM 1% FILM SMT
R221	RK45-02870	1	58900	RK45-02870	287 OHM 1% FILM SMT
R222	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R223	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R224	RK45-02870	1	58900	RK45-02870	287 OHM 1% FILM SMT
R225	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R226	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R227	RK45-00576	1	59124	RN73K2A57R6F	57.6 OHM 1% FILM SMT
R228	RN55-00475	1	91637	RN55C47R5F	47.5 OHMS 1% MET FILM
R229	RN55-00475	1	91637	RN55C47R5F	47.5 OHMS 1% MET FILM
R230	RK45-21470	1	58900	RK45-21470	14.7K OHM 1% FILM SMT
R231	RK45-05490	1	59124	RN73K2A5490F	549 OHM 1% FILM SMT
R232	RN55-00475	1	91637	RN55C47R5F	47.5 OHMS 1% MET FILM
R233	RN55-00475	1	91637	RN55C47R5F	47.5 OHMS 1% MET FILM
R234	RN55-00475	1	91637	RN55C47R5F	47.5 OHMS 1% MET FILM
R235	RN55-00475	1	91637	RN55C47R5F	47.5 OHMS 1% MET FILM
R236	RK45-32490	1	59124	RN73K2A2493F	249K OHM 1% FILM SMT
R238	RK45-32490	1	59124	RN73K2A2493F	249K OHM 1% FILM SMT
R240	RN55-00475	1	91637	RN55C47R5F	47.5 OHMS 1% MET FILM
R241	RN55-00475	1	91637	RN55C47R5F	47.5 OHMS 1% MET FILM
R242	RN55-00475	1	91637	RN55C47R5F	47.5 OHMS 1% MET FILM
R243	RN55-00475	1	91637	RN55C47R5F	47.5 OHMS 1% MET FILM
R244	RK45-00412	1	58900	RK45-00412	41.2 OHM 1% FILM SMT
R245	21445-011	1	———	RK73H2AT1002F	10.0K OHM 1% FILM SMT
R246	RN55-00475	1	91637	RN55C47R5F	47.5 OHMS 1% MET FILM
R247	RN55-00475	1	91637	RN55C47R5F	47.5 OHMS 1% MET FILM
R248	RN55-00475	1	91637	RN55C47R5F	47.5 OHMS 1% MET FILM
R249	RN55-00475	1	91637	RN55C47R5F	47.5 OHMS 1% MET FILM
R250	21445-011	1	———	RK73H2AT1002F	10.0K OHM 1% FILM SMT
R251	21445-011	1	———	RK73H2AT1002F	10.0K OHM 1% FILM SMT
R252	RN55-00475	1	91637	RN55C47R5F	47.5 OHMS 1% MET FILM
R253	RK45-23010	1	91637	CRCW08053012FT	30.1K OHM 1% FILM SMT
R254	RK45-23010	1	91637	CRCW08053012FT	30.1K OHM 1% FILM SMT
R255	21445-011	1	———	RK73H2AT1002F	10.0K OHM 1% FILM SMT
R256	21445-011	1	———	RK73H2AT1002F	10.0K OHM 1% FILM SMT
R257	RK45-12400	1	59124	RN73K2A2401F	2.4K OHM 1% FILM SMT
R258	21445-009	1	———	RK73H2AT4990F	499 OHM 1% FILM SMT
R259	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R260	RK45 09530	1	59124	RN73K2A9530F	953 OHM 1% FILM SMT
R261	RK45-09530	1	59124	RN73K2A9530F	953 OHM 1% FILM SMT
R262	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R263	RK45 05490	1	59124	RN73K2A5490F	549 OHM 1% FILM SMT
R264	RK45-05490	1	59124	RN73K2A5490F	549 OHM 1% FILM SMT
R265	RK45-05490	1	59124	RN73K2A5490F	549 OHM 1% FILM SMT

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Item	Part Number	Qty	Cage	Mfr's Part Number	Description
R266	RK45-05490	1	59124	RN73K2A5490F	549 OHM 1% FILM SMT
R267	RK45-05490	1	59124	RN73K2A5490F	549 OHM 1% FILM SMT
R268	RK45-01800	1	59124	RN73K2A1800F	180 OHM 1% FILM SMT
R269	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R270	RK45-00196	1	59124	RN73K2A19R6F	19.6 OHM 1% FILM SMT
R271	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R272	21445-001	1	65940	MCR10EZFHFX1001	1.00K OHM 1% FILM SMT
R273	RW03-00390	1	91637	RS-2B-39-1	39 OHM 3W WIREWOUND
R274	RW03-00390	1	91637	RS-2B-39-1	39 OHM 3W WIREWOUND
R275	RW03-00390	1	91637	RS-2B-39-1	39 OHM 3W WIREWOUND
RP1	14882-001	1	58900	14882-001	10K OHM X 9 SIP NETWORK
RP2	14882-001	1	58900	14882-001	10K OHM X 9 SIP NETWORK
RP3	14882-001	1	58900	14882-001	10K OHM X 9 SIP NETWORK
RT2	15208-001	1	56866	QT06002-022 Rev A	10 K OHM THERMISTOR
RT3	20607-002	1	06090	RXE050	.5A RES CIRCUIT BREAKER
RT4	20607-002	1	06090	RXE050	.5A RES CIRCUIT BREAKER
TP1	21456-001	1	58900	21456-001	BLACK TEST POINT
TP2	21456-001	1	58900	21456-001	BLACK TEST POINT
TP3	21456-001	1	58900	21456-001	BLACK TEST POINT
TP4	21456-001	1	58900	21456-001	BLACK TEST POINT
TP5	21456-001	1	58900	21456-001	BLACK TEST POINT
TP6	21456-001	1	58900	21456-001	BLACK TEST POINT
TP7	21456-001	1	58900	21456-001	BLACK TEST POINT
TP8	21456-001	1	58900	21456-001	BLACK TEST POINT
TP9	21456-001	1	58900	21456-001	BLACK TEST POINT
TP10	21456-001	1	58900	21456-001	BLACK TEST POINT
TP11	21456-001	1	58900	21456-001	BLACK TEST POINT
TP12	21456-001	1	58900	21456-001	BLACK TEST POINT
TP13	21456-001	1	58900	21456-001	BLACK TEST POINT
TP14	21456-001	1	58900	21456-001	BLACK TEST POINT
TP15	21456-001	1	58900	21456-001	BLACK TEST POINT
TP16	21456-001	1	58900	21456-001	BLACK TEST POINT
TP17	21456-001	1	58900	21456-001	BLACK TEST POINT
TP18	21456-001	1	58900	21456-001	BLACK TEST POINT
TP19	21456-001	1	58900	21456-001	BLACK TEST POINT
TP20	21456-001	1	58900	21456-001	BLACK TEST POINT
TP21	21456-001	1	58900	21456-001	BLACK TEST POINT
TP22	21456-001	1	58900	21456-001	BLACK TEST POINT
TP23	21456-001	1	58900	21456-001	BLACK TEST POINT
TP24	21456-001	1	58900	21456-001	BLACK TEST POINT
TP25	21456-001	1	58900	21456-001	BLACK TEST POINT
TP26	21456-001	1	58900	21456-001	BLACK TEST POINT
TP27	21456-001	1	58900	21456-001	BLACK TEST POINT
TP28	21456-001	1	58900	21456-001	BLACK TEST POINT
TP29	21456-001	1	58900	21456-001	BLACK TEST POINT
TP30	21456-001	1	58900	21456-001	BLACK TEST POINT
TP31	21456-001	1	58900	21456-001	BLACK TEST POINT
TP32	21456-001	1	58900	21456-001	BLACK TEST POINT
TP33	21456-001	1	58900	21456-001	BLACK TEST POINT
TP34	21456-001	1	58900	21456-001	BLACK TEST POINT
TP35	21456-001	1	58900	21456-001	BLACK TEST POINT
TP36	21456-001	1	58900	21456-001	BLACK TEST POINT
TP37	21456-001	1	58900	21456-001	BLACK TEST POINT
U1	15135	1	01295	OP-07/CP	HA5135-5 PRECISION OP AMP
U2	21189	1	17856	DG411DJ	DG411DJ QUAD SPST SWITCH
U3	15233	1	58900	15233	CA3240E DUAL OP AMP
U4	15135	1	01295	OP-07/CP	HA5135-5 PRECISION OP AMP
U5	ULN0-00393	1	01295	LM393P	LM393N VOLT COMPARATOR
U6	15093	1	64155	LM199H	LM399H 7V PRECISION ZENER
U7	15135	1	01295	OP-07/CP	HA5135-5 PRECISION OP AMP
U8	21189	1	17856	DG411DJ	DG411DJ QUAD SPST SWITCH
U9	UTN0-00322	1	01295	74HC32N	74HC32 QUAD 2 INPUT OR
U10	UTN0-00082	1	01295	SN74HC08N	74HC08N QUAD AND

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Item	Part Number	Qty	Cage	Mfr's Part Number	Description
U11	15135	1	01295	OP-07/CP	HA5135-5 PRECISION OP AMP
U12	15135	1	01295	OP-07/CP	HA5135-5 PRECISION OP AMP
U13	UIN0-07534	1	24355	AD7534JN	AD7534JN 14 BIT DAC
U14	19586	1	60395	X2444P	X2444P 256 BIT NV RAM
U15	UTN0-00042	1	01295	SN74HC04N	SN74HC04 HEX INVERTER
U16	13471	1	01295	LM324N	LM324AN QUAD OP AMP
U17	UID0-07245	1	24355	AD7245AAR	AD7245AAR 12 BIT DAC SMT
U18	21159	1	4T165	UPD71055C	uPD71055 PARALLEL INTERFACE
U19	13471	1	01295	LM324N	LM324AN QUAD OP AMP
U20	UID0-07245	1	24355	AD7245AAR	AD7245AAR 12 BIT DAC SMT
U21	21159	1	4T165	UPD71055C	uPD71055 PARALLEL INTERFACE
U22	UID0-07891	1	24355	AD7891AP-2	AD7891AP-2 MUX/ADC SMT
U23	URD1-07805	1	04713	MC78L05ACD	MC78L05ACD .1A 5V REG
U24	UOD1-01007	1	64155	LT1007CS8	LT1007CS8 OP AMP
U25	UOD0-01356	1	64155	LT1356CS	LT1356CS QUAD OPAMP SMT
U26	UOD0-00436	1	62839	CLC436AJE	CLC436AJE OP AMP SMT
U27	UOD1-01007	1	64155	LT1007CS8	LT1007CS8 OP AMP
U28	ULD0-00613	1	17856	DG613DY	DG613DY 4PST SWITCH SMT
U29	UOD0-00426	1	62839	CLC426AJE	CLC426AJE OP AMP,SMT
U31	ULD0-00409	1	17856	DG409DY	DG409DY 2X 4IN SWITCH SMT
U32	ULD0-00613	1	17856	DG613DY	DG613DY 4PST SWITCH SMT
U33	URD1-07812	1	04713	MC78M12CDT	MC78M12CDT .5A 12V REG
U34	URD0-07912	1	01295	MC79L12ACD	MC79L12ACD .1A 12V SMT
U35	URD0-07812	1	04713	MC78L12ACD	MC78L12ACD .1A 12V SMT
U36	ULD0-00642	1	17856	DG642DY	DG642DY SPDT SWITCH SMT
U37	UID0-07245	1	24355	AD7245AAR	AD7245AAR 12 BIT DAC SMT
U38	17714	1	01295	LM358AP	LM358AN DUAL OP AMP
U39	UOD0-00324	1	04713	LM324D	LM324D QUAD OP AMP SMT
U40	URD1-07912	1	01295	UA78M45CKTP	MC79M12CDT .5A -12V REG
U41	UTD0-00143	1	04713	MC74HCT14AD	74HCT14D HEX SCHMITT INV SMT
U44	ULD0-00643	1	17856	DG643DY	DG643DY 2PDT SWITCH SMT
U45	UOD0-00111	1	62839	CLC111AJE	CLC111AJE BUFFER,SMT
U46	UOD0-00111	1	62839	CLC111AJE	CLC111AJE BUFFER,SMT
U47	ULD0-00643	1	17856	DG643DY	DG643DY 2PDT SWITCH SMT
U48	UOD0-00426	1	62839	CLC426AJE	CLC426AJE OP AMP,SMT
U52	UOD0-00428	1	62839	CLC428JE	CLC428AJE OP AMP SMT
U53	UOD0-00428	1	62839	CLC428JE	CLC428AJE OP AMP SMT
U54	UOD0-01356	1	64155	LT1356CS	LT1356CS QUAD OPAMP SMT
U56	ULD0-00643	1	17856	DG643DY	DG643DY 2PDT SWITCH SMT
U57	URD0-07905	1	04713	MC79M05CDT	MC79MO5CDT .5A -5V SMT
U58	URD0-07805	1	04713	MC78M05CDT	MC78M05CDT.5A 5V REG SM
U59	UOD0-00428	1	62839	CLC428JE	CLC428AJE OP AMP SMT
U62	ULD0-00643	1	17856	DG643DY	DG643DY 2PDT SWITCH SMT
U64	ULD0-00643	1	17856	DG643DY	DG643DY 2PDT SWITCH SMT
U66	ULD0-00409	1	17856	DG409DY	DG409DY 2X 4IN SWITCH SMT
U67	UOD1-01007	1	64155	LT1007CS8	LT1007CS8 OP AMP
U68	UOD0-00426	1	62839	CLC426AJE	CLC426AJE OP AMP,SMT
U69	ULD0-00643	1	17856	DG643DY	DG643DY 2PDT SWITCH SMT
U70	UOD0-00111	1	62839	CLC111AJE	CLC111AJE BUFFER,SMT
U71	UOD1-01007	1	64155	LT1007CS8	LT1007CS8 OP AMP
U72	UOD0-00111	1	62839	CLC111AJE	CLC111AJE BUFFER,SMT
U73	ULD0-00643	1	17856	DG643DY	DG643DY 2PDT SWITCH SMT
U74	UOD0-00426	1	62839	CLC426AJE	CLC426AJE OP AMP,SMT
U76	UOD0-01356	1	64155	LT1356CS	LT1356CS QUAD OPAMP SMT
U78	UOD0-00428	1	62839	CLC428JE	CLC428AJE OP AMP SMT
U81	ULD0-00643	1	17856	DG643DY	DG643DY 2PDT SWITCH SMT
U82	URD0-07805	1	04713	MC78M05CDT	MC78M05CDT.5A 5V REG SM
U83	URD0-07905	1	04713	MC79M05CDT	MC79MO5CDT .5A -5V SMT
U86	ULD0-00643	1	17856	DG643DY	DG643DY 2PDT SWITCH SMT
U88	ULD0-00643	1	17856	DG643DY	DG643DY 2PDT SWITCH SMT
U90	ULD0-00642	1	17856	DG642DY	DG642DY SPDT SWITCH SMT
U91	UID0-01410	1	64155	LTC1410CS	LTC1410CS 12 BIT A/D SMT
U95	UOD0-01356	1	64155	LT1356CS	LT1356CS QUAD OPAMP SMT

30173 8542C ANALOG PC ASSY (A2), Rev: L

Item	Part Number	Qty	Cage	Mfr's Part Number	Description
U96	UOD0-00436	1	62839	CLC436AJE	CLC436AJE OP AMP SMT
U97	UID0-01410	1	64155	LTC1410CS	LTC1410CS 12 BIT A/D SMT
U99	ULD0-00642	1	17856	DG642DY	DG642DY SPDT SWITCH SMT
U100	ULD0-00642	1	17856	DG642DY	DG642DY SPDT SWITCH SMT
U102	URD0-07812	1	04713	MC78L12ACD	MC78L12ACD .1A 12V SMT
U103	URD0-07912	1	01295	MC79L12ACD	MC79L12ACD .1A 12V SMT
U104	30619	1	58900	30619	PROG GAL 854XC A2 U104
U105	30621	1	58900	30621	PROG GAL 854XC A2 U105
U106	30623	1	58900	30623	PROG GAL 854XC A2 U106
U107	UTD0-00742	1	01295	SN74HC74D	74HC74D DUAL D FFLOP SMT
U108	UTD0-00742	1	01295	SN74HC74D	74HC74D DUAL D FFLOP SMT
U109	UTD0-00742	1	01295	SN74HC74D	74HC74D DUAL D FFLOP SMT
U110	UTD0-40402	1	01295	74HC4040D	74HC4040D 12 BIT CT SMT
U111	30625	1	58900	30625	PROG EPROM 854XC A2 U111
U112	UGD0-09501	1	24355	AD9501JP	AD9501JP DELAY GEN SMT
U113	UTD0-00143	1	04713	MC74HCT14AD	74HCT14D HEX SCHMITT INV SMT
W1	JIA1-03230	1	58900	JIA1-03230	3 PIN STRIPLINE PLUG
XQ4	11037	1	13103	7717-22-N	TO5 NYLON INSULATOR
XW1	17240-001	1	27264	15-38-1024	JUMPER,INSULATED,2 POS

21229 FRONT PANEL PCB ASSY (A3), Rev: C

Item	Part Number	Qty	Cage	Mfr's Part Number	Description
1	21228	1	61964	21228	PCB,FR PNL
2	21230	REF	58900	21230	SCHEM, FRONT PANEL
3	14514-001	39	58900	14514-001	CONTACT POST
4	21326	0	———	4416-1/2" WHITE	1/2 X 1/16 FOAM TAPE
DS1	21262	1	28480	HDSP-4840	10 LED BAR GRAPH ARRAY
DS2	21262	1	28480	HDSP-4840	10 LED BAR GRAPH ARRAY
J1	14514-001	1	58900	14514-001	CONTACT POST
LS1	15164	1	72982	PKM11-4AO	PIEZO ALARM
R1	RN55-02210	1	91637	RN55C2210F	221 OHMS 1% MET FILM
R2	RN55-02210	1	91637	RN55C2210F	221 OHMS 1% MET FILM
R6	RN55-21000	1	91637	RN55C1002F	10 K OHMS 1% MET FILM
RP1	14882-006	1	91637	MSP10A01221G	220 OHM X 9 SIP NETWORK
RP2	14882-006	1	91637	MSP10A01221G	220 OHM X 9 SIP NETWORK
W1	21276-001	1	56501	FST-6 0.75 A-10	10 POSITION FLEX JUNPER

21240 LCD DISPLAY ASSY (A4), Rev: B

Item	Part Number	Qty	Cage	Mfr's Part Number	Description
2	30436	1	———	30436	LCD CABLE ASSEMBLY
5	21216	1	58900	21216	DISPLAY, LCD

7.3 List of Manufacturers

The names and addresses of manufacturers cited in the preceding parts lists are shown in Table 7-1. Each manufacturer is listed under its CAGE number (COMMERCIAL AND GOVERNMENT ENTITY), as noted in the parts lists. In a few cases, no CAGE number has been assigned; these manufacturers are referenced by Giga-tronics codes which are shown at the end of the list.

Table 7-1. Manufacturer's List

CAGE	NAME	ADDRESS
0ABX4	Comptec Inc	7837 Custer School Rd Custer WA 98240
0AG18	Hirose Electric USA Inc	Chatsworth CA
0AX52	Ditom Microwave Inc	1180 Coleman Ave #103 San Jose CA 95110
0BE81	Aerovox-Mallory	20 Aberdeen Dr Glasgow KY 42141
0B0A9	Dallas Semiconductor Corp	6350 Beltwood Pky S Dallas TX 75244
0B549	Siemens Components Inc Semiconductor Group	2191 Laurelwood Rd Santa Clara CA 95054
0D2A6	Mitsubishi Electronics Inc	1050 East Arques Ave Sunnyvale CA 94086
0D3V2	Menlo Industries Inc	44060 Old Warm Springs Blvd Fremont CA 94538
0EUK7	All American Transistor of California Inc	369 Van Ness Way Suite 701 Torrance CA 90501
0GP12	Radiall Inc	150 Long Beach Blvd Stratford CT 06497
0GYA7	Signal Transformer Co	500 Bayview Ave Inwood NY 11696
0HS44	Pacific Millimeter	189 Linbrook Dr San Diego CA 92111
0HFH6	Futaba Corporation of America	555 West Victoria St Compton CA 90220
0HFJ2	Microplastic	9180 Gazette Ave Chatsworth CA 91311
0HIN5	Marcon America Corp	998 Forest Edge Dr Vernon Hills IL 60061
0H379	Aerowave Inc	344 Salem St Medford MA 02155
0J7V3	Amp Inc	19200 Stevens Creek Blvd Suite 1 Cupertino CA 95014
0JNR4	Dupont Eelectronics Customer Service Center	825 Old Trail Rd PO Box 80019 Wilmington DE 19880-0019
0KA21	Stetco Inc	3344 Schierhorn Ct Franklin Park IL 60131
00443	Waveline Inc	160 Passaic Ave West Caldwell NJ 07006
00656	Aerovox Inc	740 Belleville Ave New Bedford MA 02745
00750	Air Track Mfg Corp	College Park MD
00809	Croven Crystals	500 Beech St Whitby Ontario CAN L1N5S5
00815	Midland - Ross	357 Beloit St Burlington WI 53105
01121	Allen-Bradley Co	1201 South 2nd St Milwaukee WI 53204
01295	Texas Instruments Inc	13500 N Central Expwy Dallas TX 75265
01963	Cherry Electrical Products Corp	3600 Sunset Ave Waukegan IL 60087
02113	Coilcraft Inc	1102 Silver Lake Dr Cary IL 60013-1658
02490	Electronic Devices Inc	Hampden MA
02660	Amphenol Corp	358 Hall Ave Wallingford CT 06492
02735	RCA Corp	Route 202 Somerville NJ 08876
03614	Bussman Mfg	114 Old St Rd PO Box 144 St Louis MO 63178
04222	AVX Ceramics Div of AVX Corp	19th Ave South PO Box 867 Myrtle Beach SC 29577
04426	ITW Switches	6615 West Irving Park Rd Chicago IL 60634
04552	Grace W R and Co	869 Washington St Canton MA 02021
04713	Motorola Inc	5005 East McDowell Rd Phoenix AZ 85008
05236	Jonathan Manufacturing Corp	1101 South Acacia Ave Fullerton CA 92631
05245	Corcom Inc	1600 Winchester Rd Libertyville IL 60048
05276	ITT Pomona Electronics Div	1500 E 9th St PO Box 2767 Pomona CA 91766
05791	Lyn-Tron Inc	3150 Damon Way Burbank CA 91505
05820	EG and G Wakefield Engineering	60 Audubon Rd Wakefield MA 01880
05905	Jerobee Industries Inc	Redmond WA
06049	Topaz Inc	9192 Topaz Way San Diego CA 92123

CAGE	NAME	ADDRESS
06090	Raychem Corp	300 Constitution Dr Menlo Park CA 94025-1111
06349	Cam-Lok Div Empire Product Inc	10540 Chester Rd Cincinnati OH 45215
06383	Panduit Corp	17301 Ridgeland Tinley Park IL 60477
06540	New Haven Mfg Corp Amatom Div	446 Blake St New Haven CT 06515
06776	Robinson Nugent Inc	800 East 8th St New Albany IN 47150
06915	Richco Plastics Co	5825 N Tripp Ave Chicago IL 60646-6013
07115	Corning Glass Works	Houghton Pk Corning NY 14830
07180	Sage Laboratories Inc	East Natick Industrial Park 3 Huron Dr Natick MA 01760
07263	Fairchild Semiconductor Corp	Cupertino CA
07512	Oak Materials Group Inc	McCaffery St Hoosick Falls NY 12090
07556	Calabro Industries Inc	1372 Enterprise Dr West Chester PA 19380
09022	Cornell-Dubilier Electronics	1605 East Rodney French Blvd New Bedford MA 02741
09353	C and K Components Inc	15 Riverdale Ave Newton MA 02158
09922	Burndy Corp	1 Richards Ave Norwalk CT 06856
09969	Dale Electronics Inc	East Highway 50 PO Box 180 Yankton SD 57078
1AU47	Lucas Weinschel Inc	1 Weinschel Ln PO Box 6001 Gaithersburg MD
1BH13	Fenwall Electronics Inc	64 Fountain St Framingham MA 01701-6211
1BR23	CW Industries Inc	Atlanta GA 04000
1CY63	Sierra Microwave Technology	11295-B Sunrise Gold Circle Rancho Cordova CA 95670
1DS68	Sumner Mfg Inc	Hwy 411 S-Sumner Dr PO Drawer A Rome GA 30162
1ES66	Maxim Intergrated Products	510 North Pastoria Ave Sunnyvale CA 94086
1E584	Electrical Wire Products Bay Associates Inc	150 Jefferson Dr Menlo Park CA 94025-1115
1FN41	Atmel Corp	2125 Onel Dr San Jose CA 95131
1JJ60	Applied Tooling and Mfg Inc	1115 Industrial Ave Escondido CA 92025
1W232	Spacek Labs	528 Santa Barbara St Santa Barbara CA 93101
1Y147	Virtech	805 G University Ave Los Gatos CA 95030
11532	Teledyne Relays	12525 Daphne Ave Hawthorne CA 90250
11769	Elco/Dyntech Div of Elco Corp	1225 East Wakeham Ave Santa Ana CA 92702
12020	Ovenaire Div of Electronic Tech	706 Forrest St Charlottesville VA 22901
12457	Merrimac Industries Inc	41 Fairfield Pl West Caldwell NJ 07006
13103	Thermalloy Co Inc	2021 W Valley View Lane PO Box 810839 Dallas TX 75381
13511	Amphenol Cadre Div Bunker Ramo Corp	Los Gatos CA
13708	Allied Components	Inglewood CA
13919	Burr-Brown Corp	6730 S Tucson Blvd Tucson AZ 85734
14482	Watkins-Johnson Co	3333 Hillview Ave Palo Alto CA 94304
14552	Microsemi Corp	2830 S Fairview St Santa Ana CA 92704-5948
14604	Elmwood Sensors Inc	500 Narragansett Park Dr Pawtucket RI 02861
14936	General Instrument Corp Power Semiconductor Div	600 West John St Hicksville NY 11802
15268	RHG Electronics Laboratory Inc	161 East Industry Ct Deer Park NY 11729
15450	Erie Specialty Products Inc	645 W 11th Street Erie PA 16512
15542	Mini-Circuits Laboratory	2625 East 14th St Brooklyn NY 11235
15915	Tepro of Florida Inc	2608 Enterprise Rd Clearwater FL 33517
16179	M/A-Com Omni Spectra Inc	21 Continental Blvd Merrimack NH 03054
16352	Codi Semiconductor Inc	144 Market Street Kenilworth NJ 07033
16428	Cooper Industries Inc	350 NW N St Richmond IN 47374
16453	Western Microwave Inc	495 Mercury Dr Sunnyvale CA 94086
16508	Aerovox Corp	19th Ave S PO Box 867 Myrtle Beach SC 29577
16733	Radio Frequency Systems Inc Cablewave Systems Div	60 Dodge Ave North Haven CT 06473
17217	Gore W L and Associates Inc	555 Paper Mill Rd Newark DE 19714
17540	Alpha Industries Inc	20 Sylvan Rd Woburn MA 01801
17856	Siliconix Inc	2201 Laurelwood Rd Santa Clara CA 95054
18041	Diodes Inc Power Components Div	21243 Ventura Blvd Woodland Hills CA 91364-2109
18310	Concord Electronics Corp	30 Great Jones St New York NY 10012

CAGE	NAME	ADDRESS
18324	Signetics Corp	4130 South Market Ct Sacramento CA 95834
18364	Mag-Tool Co	940 American St San Carlos CA 94070
18714	RCA Corp Findlay Plant	1700 Fostoria Rd Findlay OH 45840
18736	Voltronics Corp	West St East Hanover NJ 07936
19701	Mepco/Electra Inc	PO Box 760 Mineral Wells TX 76067
2J873	Celeritex Inc	617 River Oaks Pky San Jose CA 95134
2J899	Dynawave Inc	94 Searle St PO Box 938 Georgetown MA 01833
2M734	Panasonic Co	PO Box 1502 Secaucus NJ 07094
2M881	Harris Corp Harris Semiconductor	883 Stierling Rd Suite 8120 Mountain View CA 94043-1930
2R182	Smith H H Co	325 N Illinois St Indianapolis IN 46204-1703
2V941	Microsource Inc	1269 Corporate Ctr Pky Santa Rosa CA 95407
20550	Engineering Mfg Co	Sheboygan WI
20944	Wiltron Co	805 East Middlefield Rd Mountain View CA 94042
20999	Minnesota Mining and Mfg Co	3M Center St Paul MN 55101
21604	Buckeye Stamping Co	555 Marion Rd Columbus OH 43207
21847	TRW Microwave Inc	825 Stewart Dr Sunnyvale CA 94086
22519	Data Delay Devices	385 Lakeview Ave Clifton NJ 07011
23499	Judd Wire Inc	870 Los Vallecitos Blvd San Marcos CA 92069
23899	Van Petty Mfg Inc	1168 Tourmaline Dr Newbury Park CA 91320
23936	Pamotor	770 Airport Blvd Burlingame CA 94010
24355	Analog Devices Inc	Rt 1 Industrial Park Norwood MA 02062
24539	Avantek Inc	3175 Bowers Ave Santa Clara CA 95054
24759	Lenox-Fugle Electronics Inc	100 Sylvania Place South Plainfield NJ 07080-1448
24931	Specialty Connector Co Inc	2100 Earlywood Dr PO Box 547 Franklin IN 46131
24995	Environmental Container System	3560 Rouge River Hwy Grants Pass OR 97526
26066	Minnesota Mining and Mfg. Co	3M Center St Paul MN 55101
26629	Frequency Sources Inc	16 Maple Rd Chelmsford MA 01824
26692	B and S Tool & Die Company	2300 Sulphur Spring Rd Baltimore MD 21227
26922	Cetec Corp	9900 Baldwin Place El Monte CA 91731
26923	Control Master Products Inc	1062 Shary Circle Concord CA 94518
27014	National Semiconductor Corp	2900 Semiconductor Dr Santa Clara CA 95051
27264	Molex Inc	2222 Wellington Ct Lisle IL 60532
27802	Vectron Laboratories Inc	166 Gover Ave Norwalk CT 06850
27851	Film Microelectronics	17 A St Burlington MA 01803
28480	Hewlett Packard Co	3000 Hanover St Palo Alto CA 94304
28520	Heyco Molded Products	750 Boulevard PO Box 160 Kenilworth NJ 07033
29005	Storm Products Co	112 South Glasglow Ave Inglewood CA 90301
29111	Trak Microwave Corp	735 Palomar Ave Sunnyvale CA 94086
29990	American Technical Ceramics	One Nordon Lane Huntington Stn NY 11746
3A054	McMaster-Carr Supply Co	9630 Norwalk Blvd Santa Fe Springs CA 90670
3E364	Vemaline	333 Strawberry Field Rd Warwick RI 02887
3W023	Philips Components Discrete Product Div	5083 Kings Hwy Saugerties NY 12477
3Z990	Tech Pro Inc	6243 E US Hwy 98 Panama City FL 32404-7434
30035	Jolo Industries Inc	13921 Nautilus Dr Garden Grove CA 92643-4026
30817	Instrument Specialties Co Inc	Exit 53 Route 80 PO Box A Delaware Water Gap PA 18327
31433	Kemet Electronics Corp	2835 Kemet Way Simpsonville SC 29681
31703	Gudrun Frederickson Co	Oakland CA
31757	Micrpac Industries Inc	905 E Walnut St Garland TX 75040
31781	Edac Inc	40 Tiffield Rd Scarborough Ont CAN M1V 5B6
31918	ITT Schadow Inc	8081 Wallace Rd Eden Prarie MN 55344
32293	Intersil Inc	2450 Walsh Ave Santa Clara CA 95051
32559	Bivar Inc	4 Thomas St Irvine CA 92718
32767	Griffith Plastics Corp	1027 California Dr Burlingame CA 94010

CAGE	NAME	ADDRESS
32997	Bourns Inc Trimpot Division	1200 Columbia Ave Riverside CA 92507
33592	Miteq Inc	100 Davids Dr Huappauge NY 11787
34031	Analog Devices	7810 Success Rd Greensboro NC 27409
34078	Midwest Microwave Inc	3800 Packard Rd Ann Arbor MI 48104
34335	Advanced Micro Devices Inc	901 Thompson Place Sunnyvale CA 94086
34553	Amperex Electronic Corp	Hauppauge NY 32732
34576	Rockwell International Corp	4311 Jamboree Rd Newport Beach CA 92660
34781	MCW Industries	129 Southside Drive Charlotte NC 28210
34785	Dek Inc	3480 Swenson Ave St Charles IL 60174
36437	Star Stainless Products Ltd	Montreal Que CAN H4T1N8
4F708	Hammond Mfg Co US Inc	1690 Walden Drive Buffalo NY 14225
4R125	Magnetec Corp	61 W Dudleytown Rd Bloomfield CT 06002
4S028	Brady W M Co Industrial Products Div	Milwaukee WI
4T165	NEC Electronics USA Inc Electron Div	401 Ellis St P.O. Box 7241 Mountain View CA 94039
4U402	Roederstein Electronics Inc	2100 W Front St Statesville NC 28677-3651
4U751	Advanced Semiconductors Inc	7525 Etmel Ave Unit 6 North Hollywood CA 91605-1912
46384	Penn Engineering & Mfg Corp	Old Easton Rd PO Box 1000 Danboro PA 18916
5H281	Allmetal Screw Products	Arlington TX
5J927	Interface Technology Div of Dynatech Corp	2100 E Alcosta Ave Glendora CA 91740
50721	Datel Inc	11 Cabot Blvd Mansfield MA 02048
51167	Aries Electronics Inc	62 Trenton Ave Frenchtown NJ 08825
51284	Mos Technology Inc	950 Rittenhouse Rd Norristown PA 19401
51642	Centre Engineering Inc	2820 East College Ave State College PA 16801
51705	Ico-Rally Corp	2575 East Bayshore Rd Palo Alto CA 94303
52063	Exar Integrated Systems	2222 Gume Dr PO Box 49007 San Jose CA 95161-9007
52072	Circuit Assembly Corp	18 Thomas St Irvine CA 92718
52648	Plessey Trading Corp	1641 Kaiser Ave Irvine CA 92714
52683	Baytron Co Inc	344 Salem St Medford MA 02155
52763	Stettner Electronics Inc	6135 Airways Blvd Chattanooga TN 37421
52840	Western Digital Corp	3128 Red Hill Ave Costa Mesa CA 92626
53387	Minnesota Mining & Mfg Co Electronic Products Div 3M	Austin TX
53421	Tyton Corp	7930 N Faulkner Rd PO Box 23055 Milwaukee WI 53223
53673	Thomson-CSF Components Corp	6660 Variel Ave Canoga Park CA 91304
54186	Micro Power Systems Inc	3100 Alfred St Santa Clara CA 95050
54343	Riedel M W and Co	300 Cypress Ave Alhambra CA 91801
54487	Micronetics Inc	36 Oak St Norwood NJ 07648
54516	National Cable Molding Corp	136 San Fernando Rd Los Angeles CA 90031
54558	SDI Inc	North Billerica MA
54583	TDK Electronics Corp	12 Harbor Park Dr Port Washington NY 11550
55153	Dielectric Laboratories Inc	69 Albany St Cazenovia NY 13035
55261	LSI Computer Systems Inc	1235 Walt Whitman Rd Melville NY 11747
55285	Bergquist Co Inc	5300 Edina Industrial Blvd Minneapolis MN 55435
55322	Samtec Inc	810 Progress Blvd PO Box 1147 New Albany IN 47150
55387	Pamtech	8030 Remmet Ave Canoga Park CA 91304
55566	RAF Electronic Hardware Inc	95 Silvermine Rd Seymour CT 06483-3915
55576	Synertek	3001 Stender Way Santa Clara CA 95051
55680	Nichicon America Corp	927 E State Pky Schaumburg IL 60195
55801	Compensated Devices Inc	166 Tremont St Melrose MA 02176-2204
55989	Semicon Inc Div of the Lorvic Corp	8810 Frost Ave St. Louis MO 63134-1002
56248	Consolidated Refining Co	115 Hoyt Ave Mamaroneck NY 10543
56289	Sprague Electric Co	87 Marshall St North Adams MA 01247
56501	Thomas & Betts Corp	1001 Frontier Rd Bridgewater NJ 08807
56563	Alatec Products	12747 Saticoy St North Hollywood CA 91605

CAGE	NAME	ADDRESS
56866	Quality Thermistor Inc	2147 Centurion Pl Boise ID 83709
57032	Daden Associates Inc	23011 Moulton Pky A-12 Laguna Hills CA 92653
57793	United Microwave Products Inc	185 West 205th St Torrance CA 90503
57834	Brim Electronics Inc	120 Home Pl Lodi NJ 07644-1514
58090	Thermometrics Inc	808 Rt 1 Edison NJ 08817-4624
58202	Innowave Inc	15555 Concord Circle Morgan Hill CA 95037
58361	General Instrument Corp Optoelectronics Div	3400 Hillview Ave Palo Alto CA 94304
58377	National Electronics	11731 Markon Dr Garden Grove CA 92641
58684	Magnetec Corp	61 W Dudleytown Rd Bloomfield CT 06002
58756	CTS Corp Electromechanical Div	1142 W Beardsley Ave Elkhart IN 46514
58758	Zambre Co Inc	2134M Old Middlefield Way Mountain View CA 94043-2404
58900	Giga-tronics Inc	4650 Norris Canyon Road San Ramon CA 94583
59124	KOA Speer Electronics Inc	Bolivar Dr PO Box 547 Bradford PA 16701
59365	Metelics Corp	975 Stewart Dr Sunnyvale CA 94086
59660	Tusonix Inc	2155 N Forbes Blvd #107 Tucson AZ 85745
59942	AVX Filters Corp	11144 Penrose St Sun Valley CA 91352
59980	Midwest Polychem Ltd	1502 N 25th Ave Melrose Park IL 60160
6A566	Tecknit Corp	320 North Nopal St Santa Barbara CA 93103
6V806	Frammar Mfg Inc (formerly Omni Spectra Corp)	6859 Tujunga Ave North Hollywood CA 91605
6Y341	Microwave Technology Inc	4268 Solar Way Fremont CA 94538
60393	Precision Resistive Products	655 Main St Mediapolis IA 52637
60395	Xicor Inc	851 Buckeye Ct Milpitas CA 95035
60450	Microwave Components Inc	7 Meehan Dr Chelmsford MA 01824
60583	Narda Microwave Corp	11040 White Rock Rd Suite 200 Rancho Cordova CA 95670
60644	CSDC	PO Box 2116 Wayne NJ 07470
61104	Aris Engineering Corp	30 Bond St Haverhill MA 01830
61429	Fox Electronics Inc	5570 Enterprise Pky Ft. Myers FL 33905
61485	Hitachi Denshi America Ltd	175 Crossways Park W Woodbury NY 11797
61529	Aromat Corp	629 Central Ave New Providence NJ 07974
61638	Advanced Interconnections	5 Energy Way West Warwick RI 02893
61772	Integrated Device Technology	3236 Scott Blvd PO Box 58015 Santa Clara CA 95052
61802	Toshiba International	13131 West Little York Rd Houston TX 77041
61964	Omron Electronics Inc	1E Commerce Schaumburg IL 60173
62277	Atlas Wire and Cable Corp	133 S Van Norman Rd Montebello CA 90640
62331	Krytar Inc	1292 Anvilwood Ct Sunnyvale CA 94086
62559	Schroff Inc	170 Commerce Dr Warwick RI 02886
62643	United Chemicon Inc	9806 Higgins St Rosemont IL 60018
63058	McKenzie Socket Technology Inc	44370 Old Warm Springs Blvd Fremont CA 94538
63132	Time Microwave	398 Martin Ave Santa Clara CA 95050
63345	Overland Products Co Inc	1687 Airport Rd Fremont NE 68025
63468	Electro Dynamics	5625 Foxridge Dr Shawnee Mission KS 66201
63542	Hall-Mark Electronics Corp	11333 Pagemill Rd Dallas TX 75243
64135	Filter Concepts	2624 S Rousselle St Santa Ana CA 92707
64155	Linear Technology Corp	1630 McCarthy Blvd Milpitas CA 95035
64671	Inmet Corp	300 Dino Dr Ann Arbor MI 48103
64859	AP Products Inc	9325 Progress Parkway Mentor OH 44061
65032	Rogers Corp	PO Box 700 Chandler AZ 85224
65449	Amtex Intl Inc	1878 Star Batt Rochester MI 48063
65517	Ayer Engineering Co	1250 West Roger Rd Tucson AZ 85705
65664	Catamount Mfg Inc	158 Governor Dr PO Box 720 Orange MA 01364
65940	Rohm Corp	8 Whatney Irvine CA 92714
65964	EVOX RIFA Inc	100 Tri-State Intl. Suite 290 Lincolnshire IL 60069
66039	Kaycor International	1732 Central St Evanston IL 60201

CAGE	NAME	ADDRESS
66148	Fairlane Fluid/Air Products	23435 Industrial Park Dr Farmington MI 48024
66449	Microsource Inc	1269 Corporate Center Pky Santa Rosa CA 95407
66466	Standard Instrumentation Inc	3322 Pennsylvania Ave Charleston WV 25302
66544	Continental Microwave & Tool Co	10 Merrill Industrial Dr Hampton NH 03842-0998
66579	Waferscale Intergraton	47280 Kato Rd Fremont CA 94538
66958	SGS Semiconductor Corp	7117 E 3rd Ave Scottsdale AZ 52251
67297	Herotek Inc.	222 N Wolfe Rd Sunnyvale CA 94086
68459	River Run Enterprises Inc	2001 Jefferson Davis Ave Selma AL 36701
68630	Tadiran Electronics Industries Inc	3000 Dundee Rd Northbrook IL 60062
7E222	Littlefuse Tracor Inc	800 E Northwest Hwy Des Plaines IL 60016
7E585	Zero Mfg	777 Front St Burbank CA 91303
7M800	Analog Devices Inc	2444 Moorpark Ave San Jose CA 95128
7U905	Seastrom Inc	2351 Kentucky Ave Indianapolis IN 46241-4827
7W263	Huber and Suhner Ltd	Tumbleinstrass 20 Pfaffikon Switz CH-8330
70364	American Electric Switch Corp	Route 4 Rocky Hill Hwy Lancaster SC 29720
70903	Belden Corp	200 South Batavia Ave Geneva IL 60134
71034	Bliley Electric Co	2545 W Grandview Blvd Erie PA 16508
71218	Bud Industries	4605 E 355th St Willoughby OH 44094
71450	CTS Corp	1201 Cumberland Ave West Lafayette IN 47906
71468	ITT Corp ITT Cannon Div	666 E Dyer Rd Santa Ana CA 92702
71785	Labinal Components and Systems Inc	1521 Morse Ave Elk Grove Village IL 60007
72259	Nytronics Inc	475 Park Ave South New York NY 10016
72982	Murata Erie North America Inc	645 West 11th St Erie PA 16512
73138	Beckman Industrial	4141 Palm St Fullerton CA 92635
73734	Federal Screw Products Inc	3917 N Kedzie Ave Chicago IL 60618-3415
74840	Illinois Capacitor Inc	3757 W Touhy Ave Lincolnwood IL 60645
74970	Johnson E F Co	299 10th Ave South West Waseca MN 56093
75263	Keystone Carbon Co Inc	1935 State St St Marys PA 15857
75332	Kings Electronics Co Inc	Brooklyn NY (relocated; see CAGE 91836)
75378	CTS Knights Inc	400 Reimann Ave Sandwich IL 60548
75915	Tracor Littlefuse Inc	800 East Northwest Hwy Des Plains IL 60016
78553	Eaton Corp Engineered Fasteners Div	14701 Detroit Ave Lakewood OH 44107-4101
79963	Zierick Mfg Co	Radio Circle Mt Kisko NY 10549
8B649	Intel Corp	3065 Bowers Ave Santa Clara CA 95051
8E631	Solitron-MIC	Port Salerno FL (relocated; see CAGE 95077)
8G639	Wavecom	Sunnyvale CA 94086
8K805	Omni Spectra Inc	Los Altos CA
8Z313	LMS Electronics	34101 Monroe Rd Charlotte NC 28205
81073	Grayhill Inc	561 Hillgrove Ave La Grange IL 60525
81312	Winchester Electronics	400 Park Rd Watertown CT 06795
81349	Military specification promulgated by military departments/agencies under authority of Defense Standardization Manual 4120 3-M	
81703	Mulberry Metal Products Inc	2199 Stanley Terrace Union NJ 07083
81774	Carol Wire and Cable Corp	249 Roosevelt Ave Pawtucket RI 02860
82152	Transco Products Inc	4241 Glenco Ave Marina Del Ray CA 90295
82199	Polarad Electronics Inc	5 Delaware Drv Lake Success NY 11042
82877	Rotron Inc	7 Hasbrouck Lane Woodstock NY 12498
83330	Kulka Smith Inc	1913 Atlantic Ave Manasquan NJ 08736
84084	American Iron and Machine Work	720 Industrial Blvd Oklahoma City OK
84171	ARCO Electronics	400 Moreland Rd Commack NY 11725-5707
84411	American Shizuki Corp	301 W O St Ogallala NE 69153
86797	Rogan Corp	3455 Woodhead Dr Northbrook IL 60062
88245	Winchester Electronics	13536 Saticoy St Van Nuys CA 91409
89110	Amp Inc	1595 South Mt Joy St Elizabethtown PA 17022

CAGE	NAME	ADDRESS
9B003	Dynamics Corp of America Electronics Systems Div	Encino CA
9W826	EZ Form Cable Corp	315 Peck St Bldg 24 New Haven CT 06513
9Z397	Fujitsu Component of America Inc	3320 Scott Blvd Santa Clara CA 95054-3101
90201	Mallory Capacitor Co	4760 Kentucky Ave Indianapolis IN 46206
91303	KOL Inc	St Paul MN
91506	Augat Inc	452 John Dietsch Blvd Attleboro Falls MA 02763
91637	Dale Electronics Inc	1122 23rd St Columbus NE 68601-3632
91662	Elco Corp	Industrial Park Huntington PA 16652
91833	Keystone Electronics Corp	31-07 20th Rd Astoria NY 11105
91836	Kings Electronics Co Inc	40 Marbledale Road Tuckahoe NY 10707-3420
92194	Alpha Wire Corp	711 Lidgerwood Ave Elizabeth NJ 07207
93459	Weinschel Engineering Co	1 Weinschel Lane Gaithersburg MD 20877
94696	Magnecraft	1910 Techny Rd Northbrook IL 60062
95054	Sermax Corp	Milwaukee WI
95077	Solitron Devices Inc Solitron/Microwave Div	1177 Blue Heron Blvd Bldg 2 Riviera Beach FL 33404
95146	Alco Electronics Products Inc	1551 Osgood St North Andover MA 01845
95275	Vitramon Inc	Box 544 Bridgeport CT 06601
95348	Gordos Arkansas Inc	1000 N 2nd St PO Box 824 Rogers AR 72757
95987	Weskesser Co Inc	727 West Glendale Ave Milwaukee WI 53209
96341	Microwave Associates Inc	NW Industrial Park S Ave Burlington MA 01803
96733	San Fernando Electric Mfg Co	1501 First St San Fernando CA 91341
98291	ITT Sealectro	585 E Main St New Britain CT 06051
99800	American Precision Industries Inc Delevan Div	270 Quaker Rd East Aurora NY 14052-2114
99899	Narda Microwave/Loral Corp	435 Moreland Rd Hauppage NY 11788

8 Diagrams

8.1 Introduction

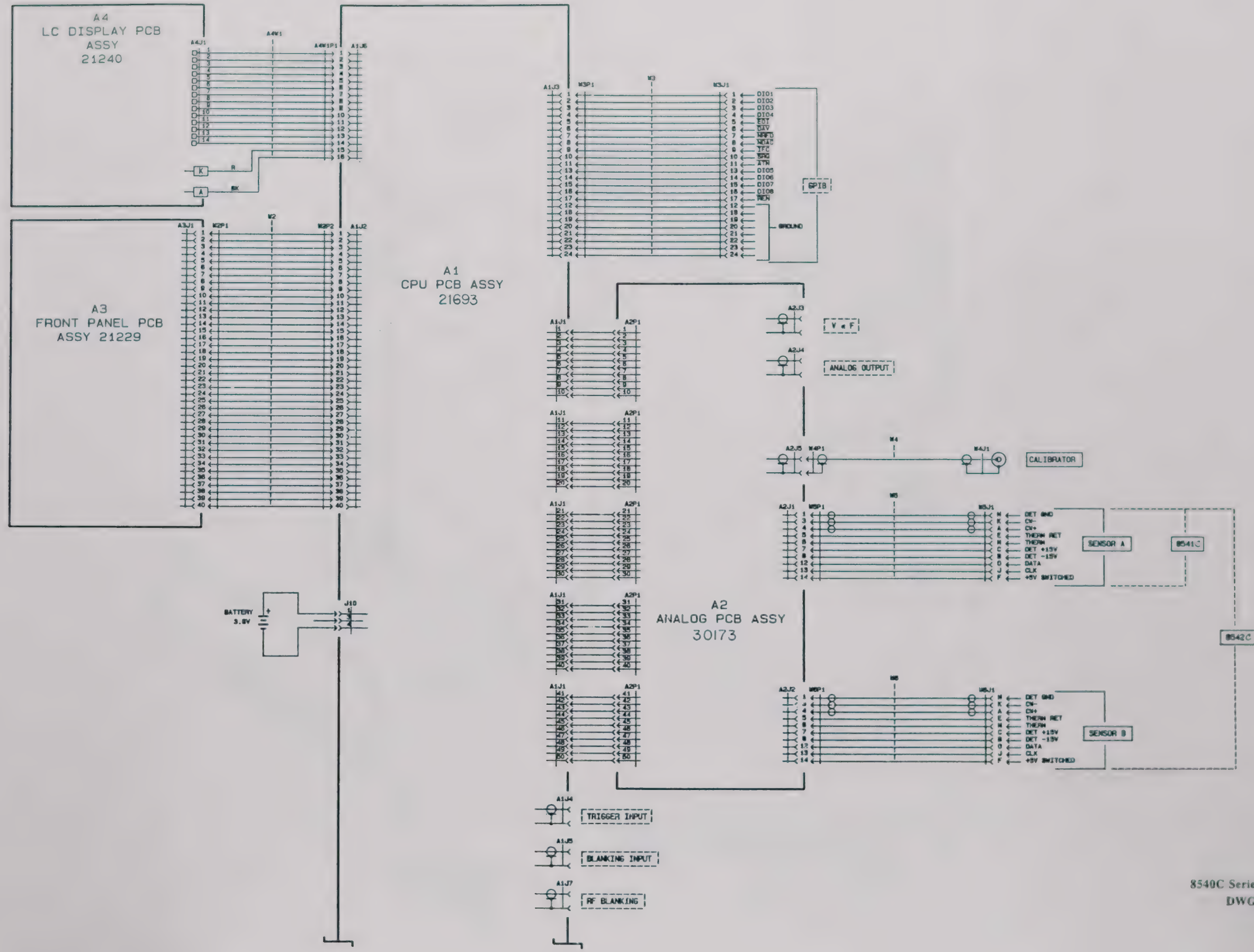
Diagrams for the following assemblies and circuits are included in this chapter:

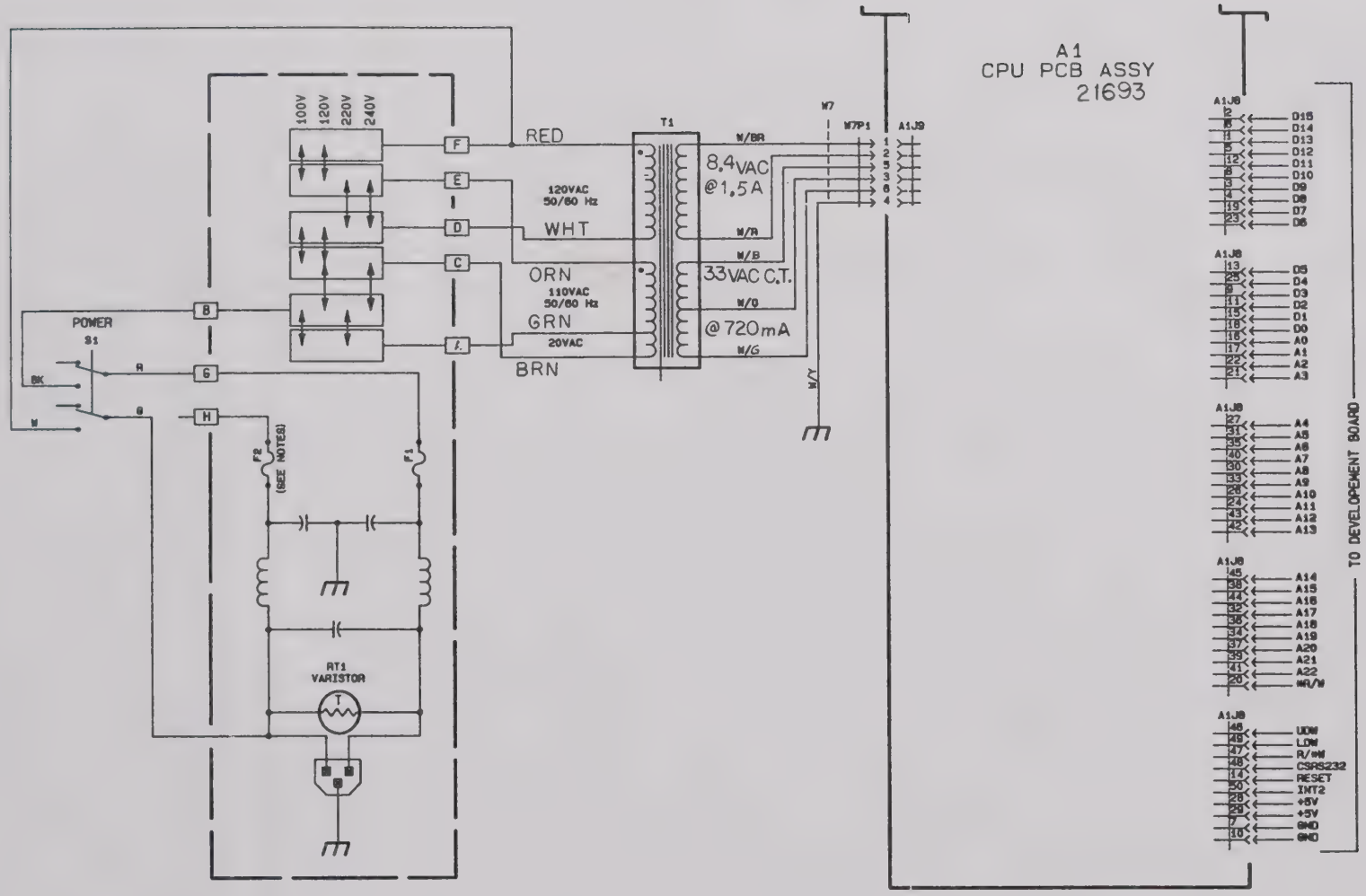
Reference Designation	Description	No. of Sheets	Drawing Number	Rev. Level	Page Number
	8540C Series Power Meter	2	30161	B	8-3
	8542C Chassis Assembly	3	30172	J	8-5
A1	8540C CPU PCB Assembly	1	21693	G	8-8
A1	8540C CPU Circuit Schematic	3	21694	G	8-9
A2	8540C Analog PCB Assembly	2	30173	L	8-12
A2	8540C Analog Circuit Schematic (6 sheets)	6	30165	J	8-14
A3	Front Panel PCB Assembly	1	21229	C	8-20
A3	Front Panel Circuit Schematic	1	21230	C	8-21
Option 06	System Schematic	1	30535	B	8-22
2nd Analog	PCB Assembly	1	21387	B	8-23
Output	Circuit Schematic	1	21388	A	8-24
Option 11	System Schematic	1	30485	B	8-25
Time Gating	PCB Assembly	1	30442	B	8-26
Measurement	Circuit Schematic	1	30443	B	8-27

8.2 Applicability

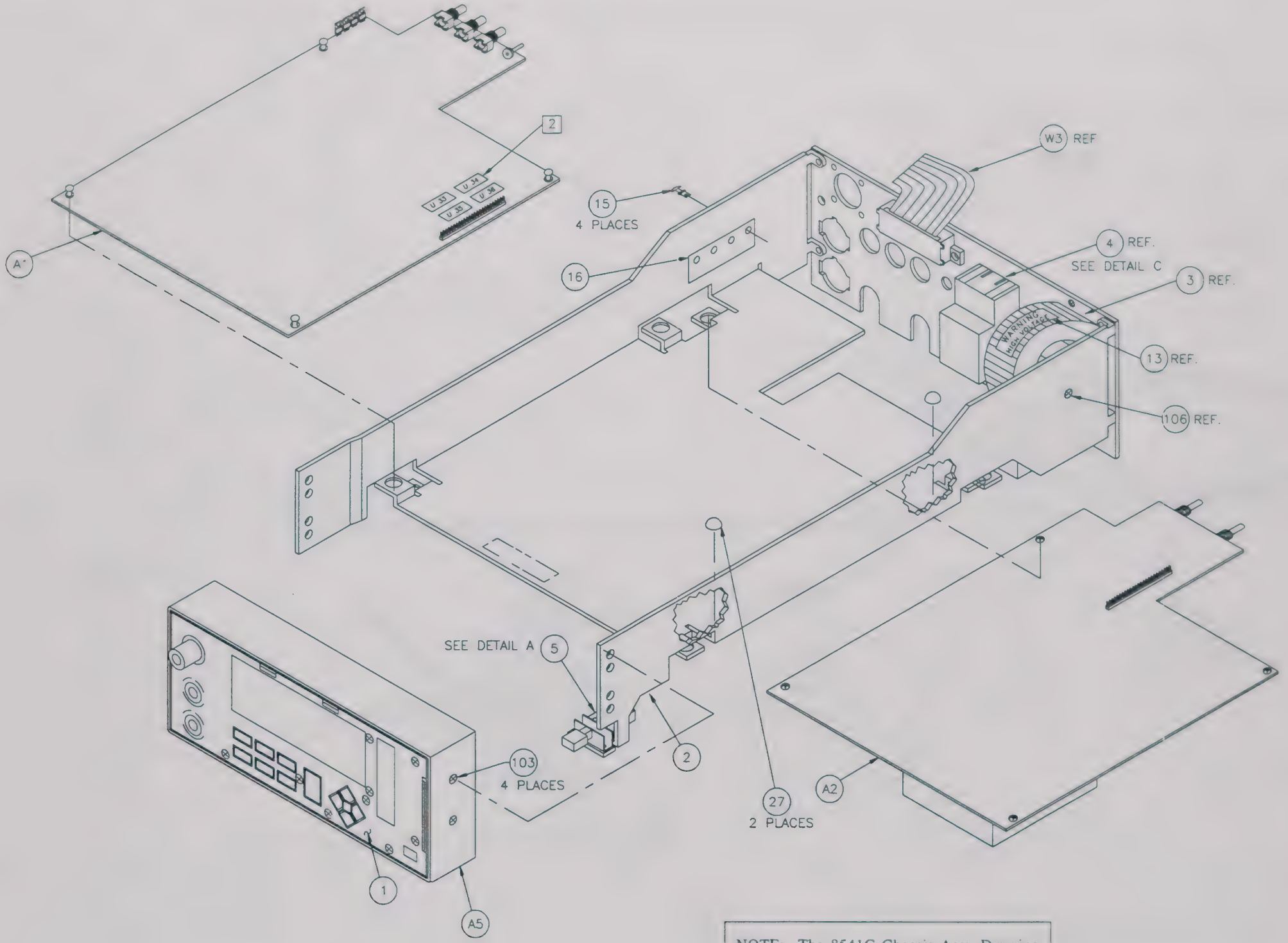
The component assemblies and circuit schematics in this chapter (except Option 06) are valid for both Model 8541C and Model 8542C. The 8541C has only one channel, therefore all references to Channel B in the assembly and circuit diagrams pertain only to the 8542C.

Parts lists for all assemblies are contained in Chapter 7. Parts lists for options are in Appendix C.

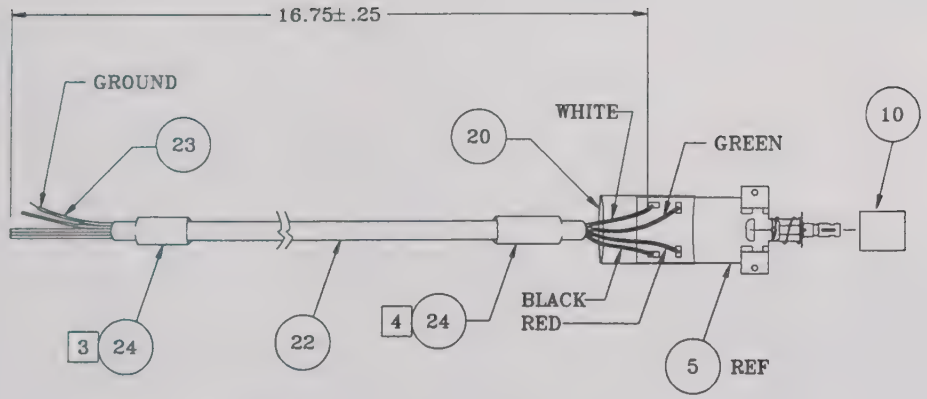

A4
LC DISPLAY PCB
ASSY
21240
A3
FRONT PANEL PCB
ASSY 21229
A1
CPU PCB ASSY
21693
A2
ANALOG PCB ASSY
30173
BATTERY
3.6V
J10
GPIB
GROUND
V ⇄ F
ANALOG OUTPUT
CALIBRATOR
SENSOR A
SENSOR B
8541C
8542C
TRIGGER INPUT
BLANKING INPUT
RF BLANKING



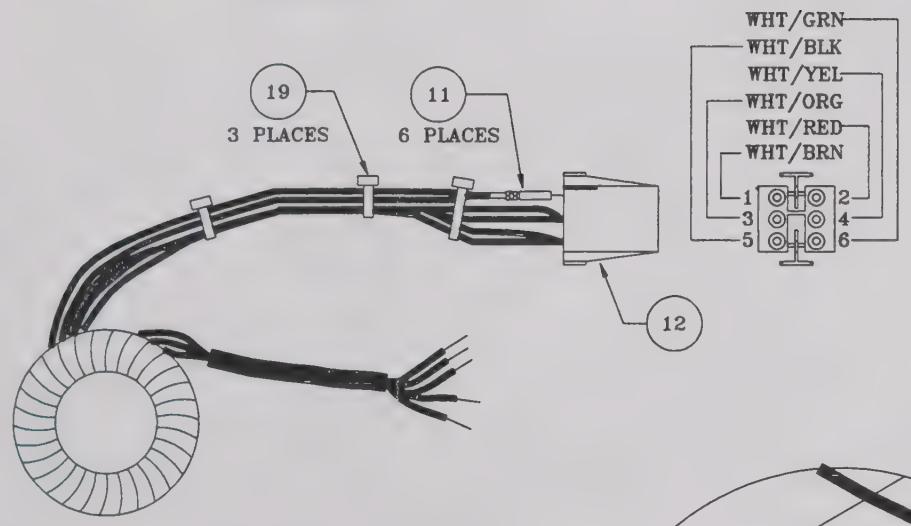
NOTES (UNLESS OTHERWISE SPECIFIED):
1. F2 IS PROVIDED FOR DUAL EUROPEAN FUSING.



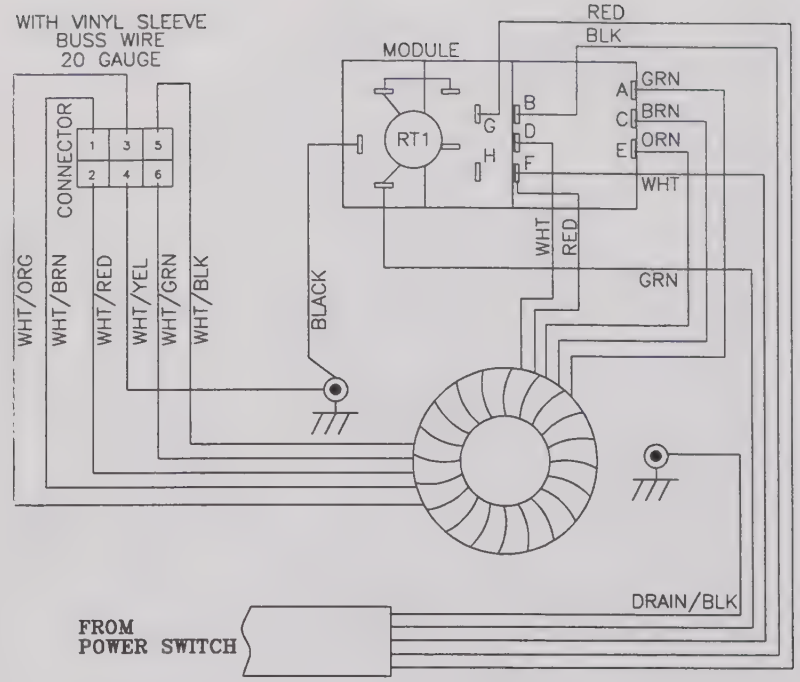
NOTE: The 8541C Chassis Assy Drawing #30160 is identical to this drawing except that it has a single RF output on the front panel.



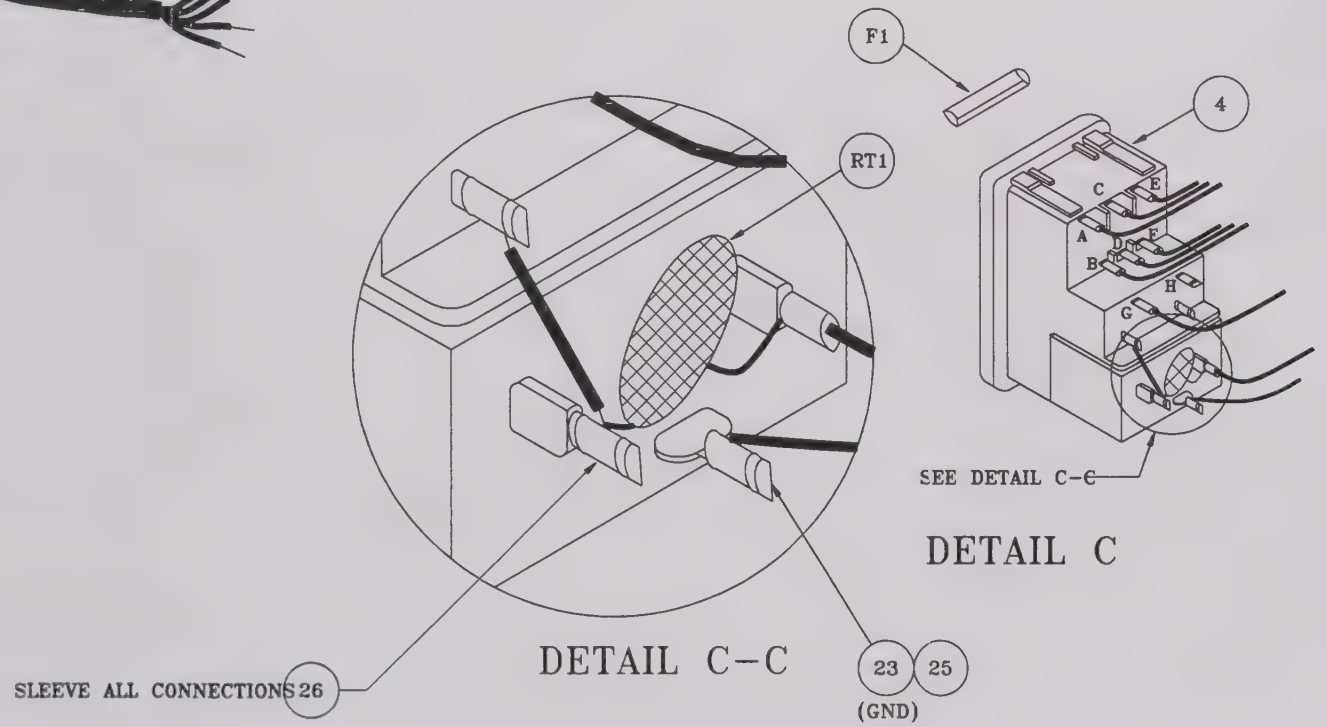
DETAIL A



DETAIL B



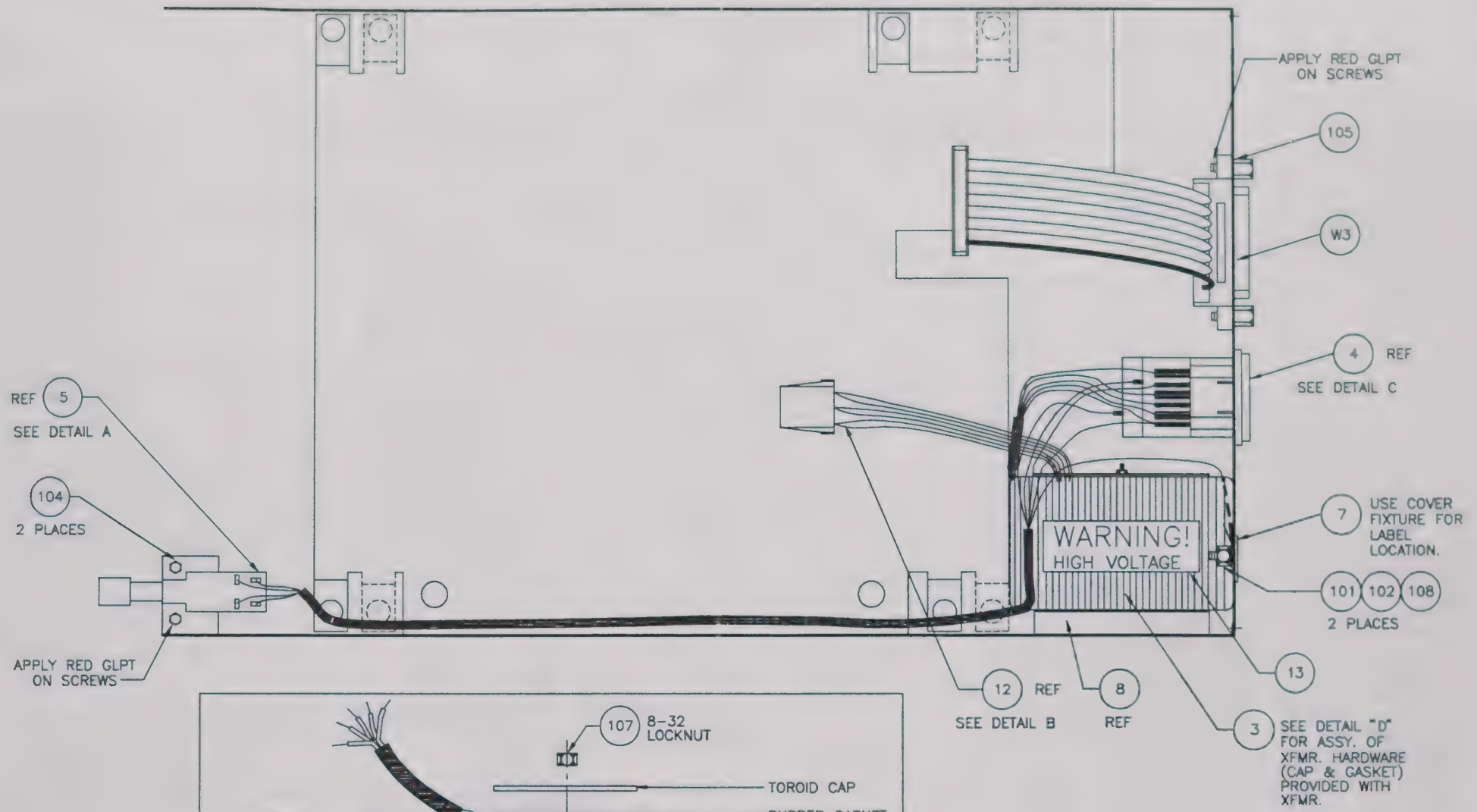
WIRING DIAGRAM (6)

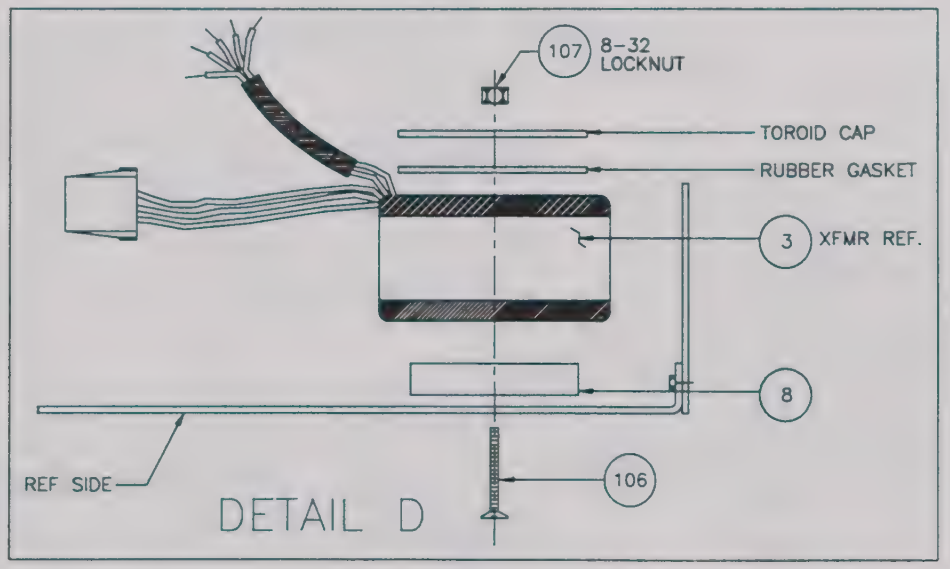


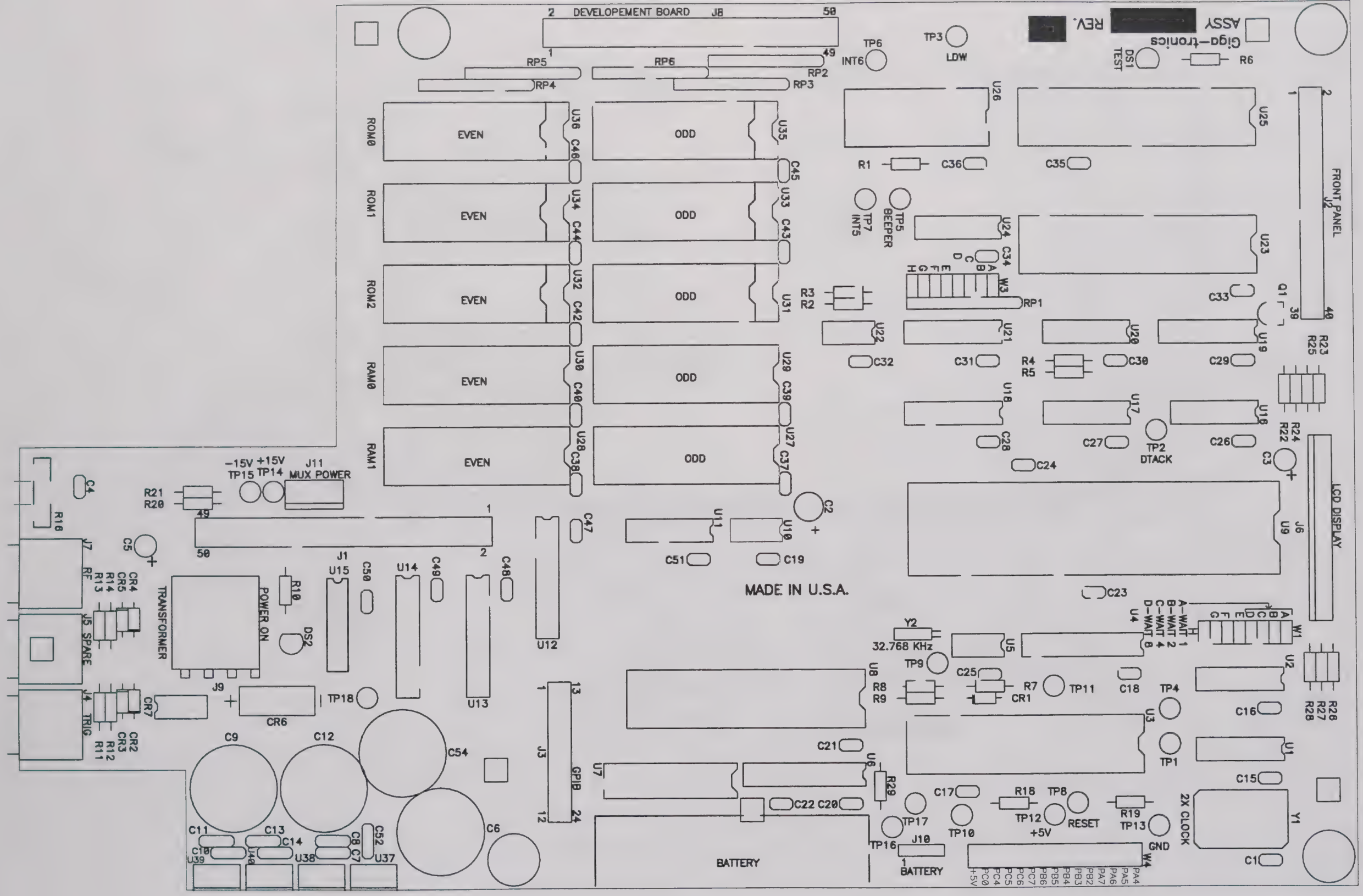
DETAIL C

DETAIL C-C

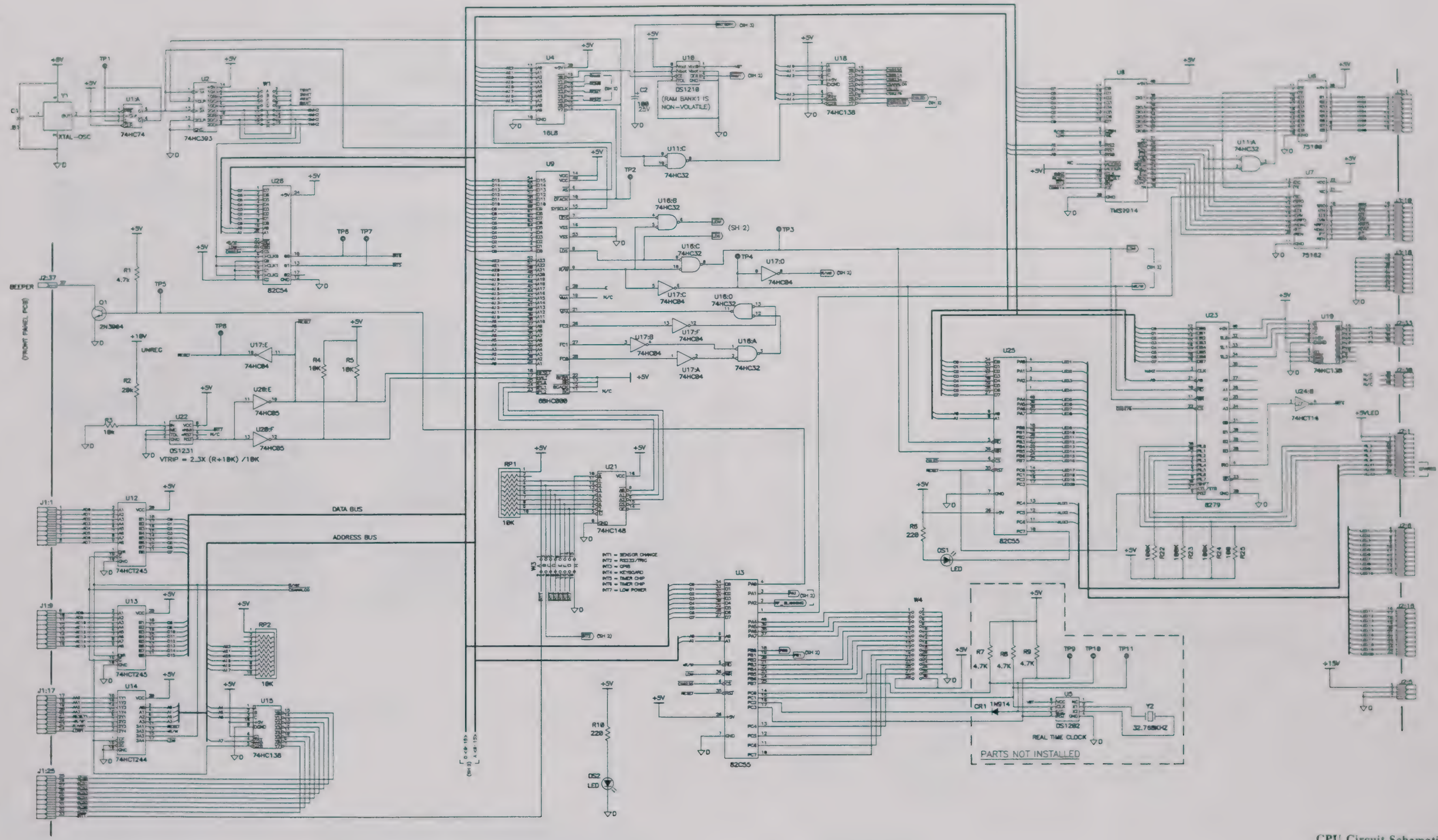
8542C Chassis Assy
DWG# 30172 Rev J
Sheet 2 of 3
8-6


APPLY RED GLPT ON SCREWS
105
W3
4 REF
SEE DETAIL C
REF 5
SEE DETAIL A
104
2 PLACES
WARNING!
HIGH VOLTAGE
7 USE COVER FIXTURE FOR LABEL LOCATION.
101 102 108
2 PLACES
APPLY RED GLPT ON SCREWS
12 REF
SEE DETAIL B
8
REF
13
3 SEE DETAIL "D" FOR ASSY. OF XFMR. HARDWARE (CAP & GASKET) PROVIDED WITH XFMR.

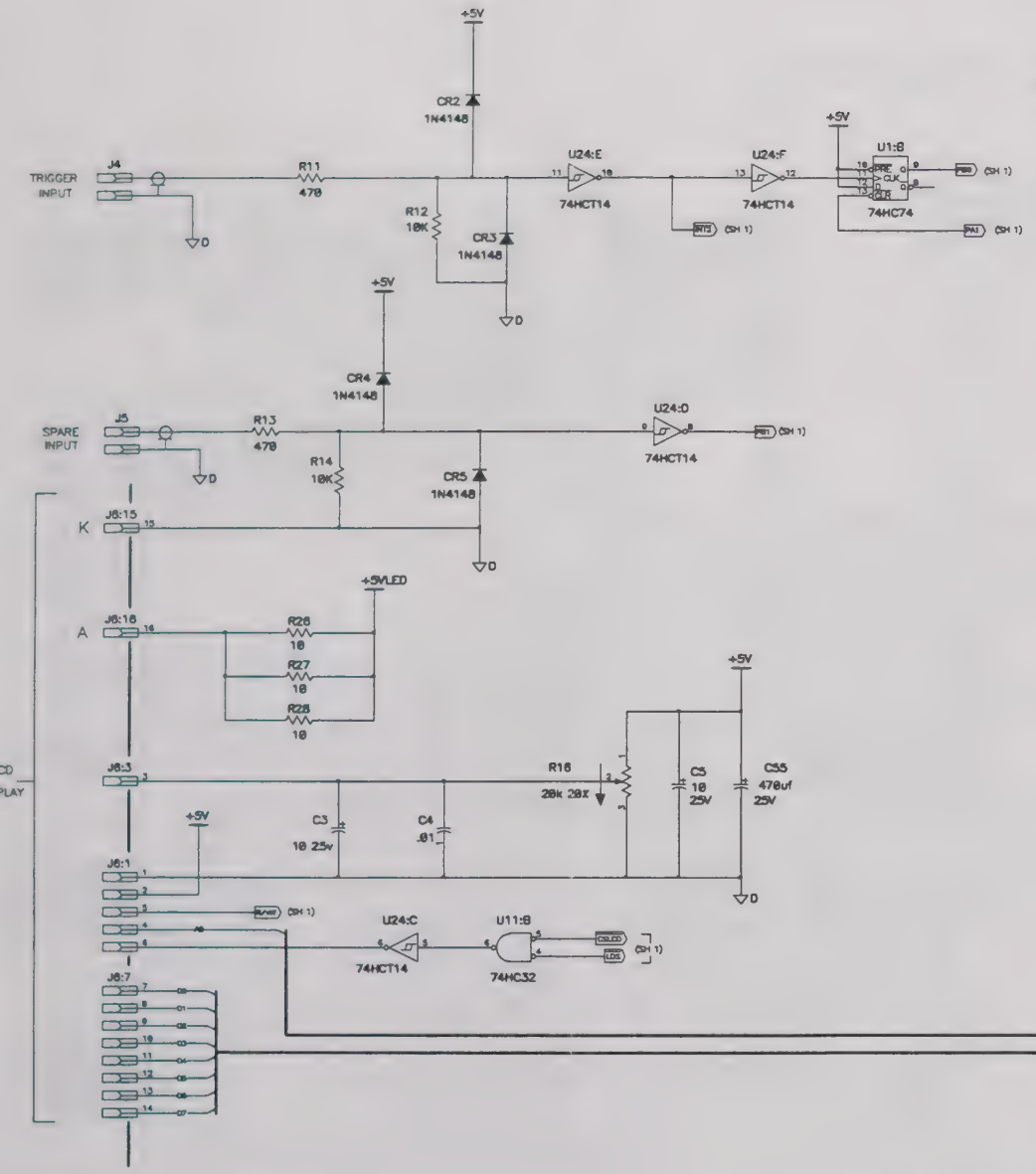

107 8-32 LOCKNUT
TOROID CAP
RUBBER GASKET
3 XFMR REF.
8
REF SIDE
106
DETAIL D

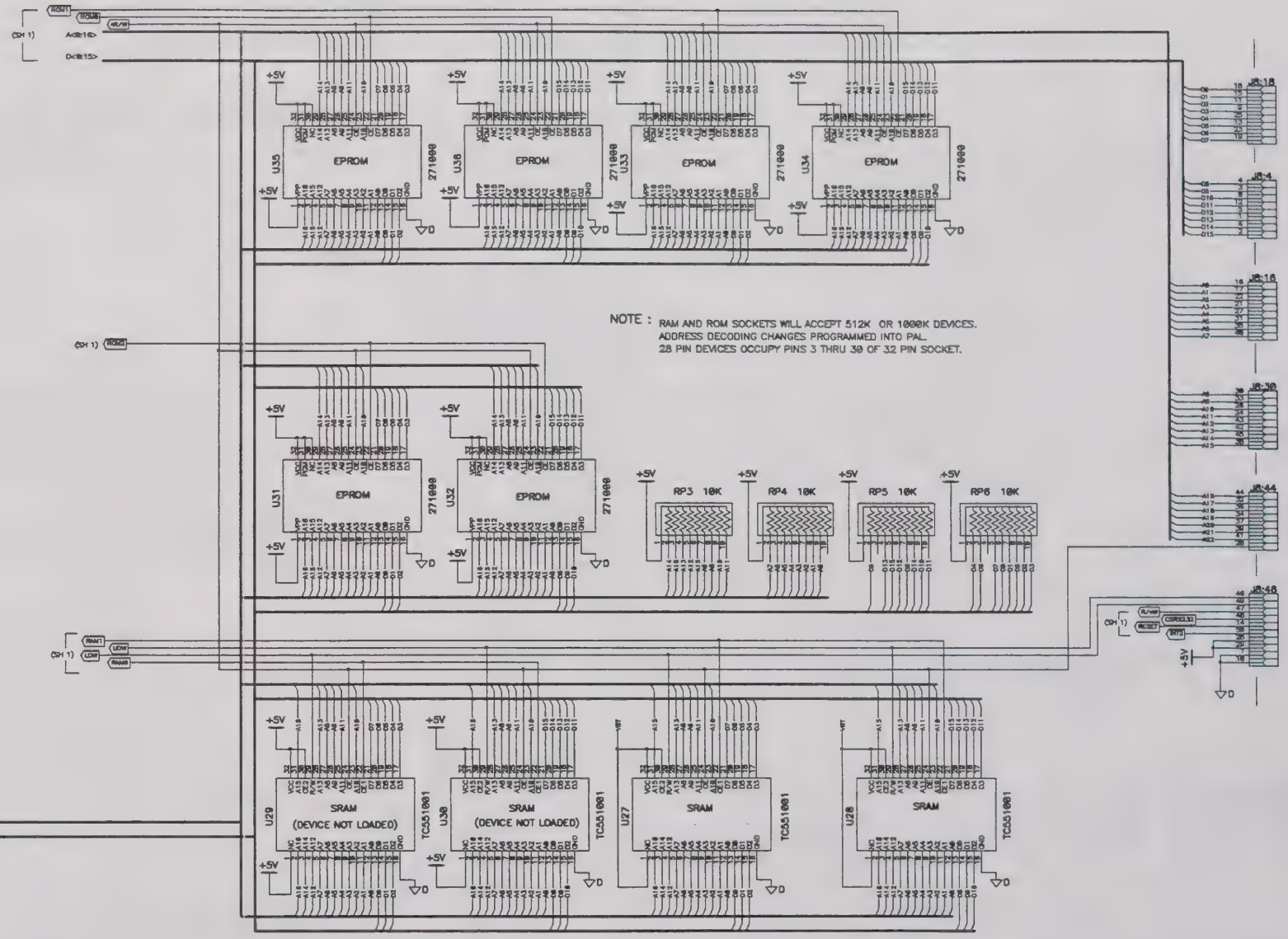


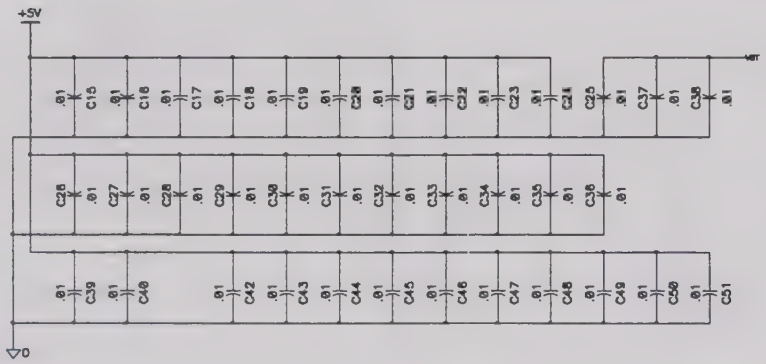
CPU PC Assy (A1)
DWG# 21693 Rev G
Sheet 1 of 1



CPU Circuit Schematic (A1)
DWG# 21694 Rev G
Sheet 1 of 3
8-9

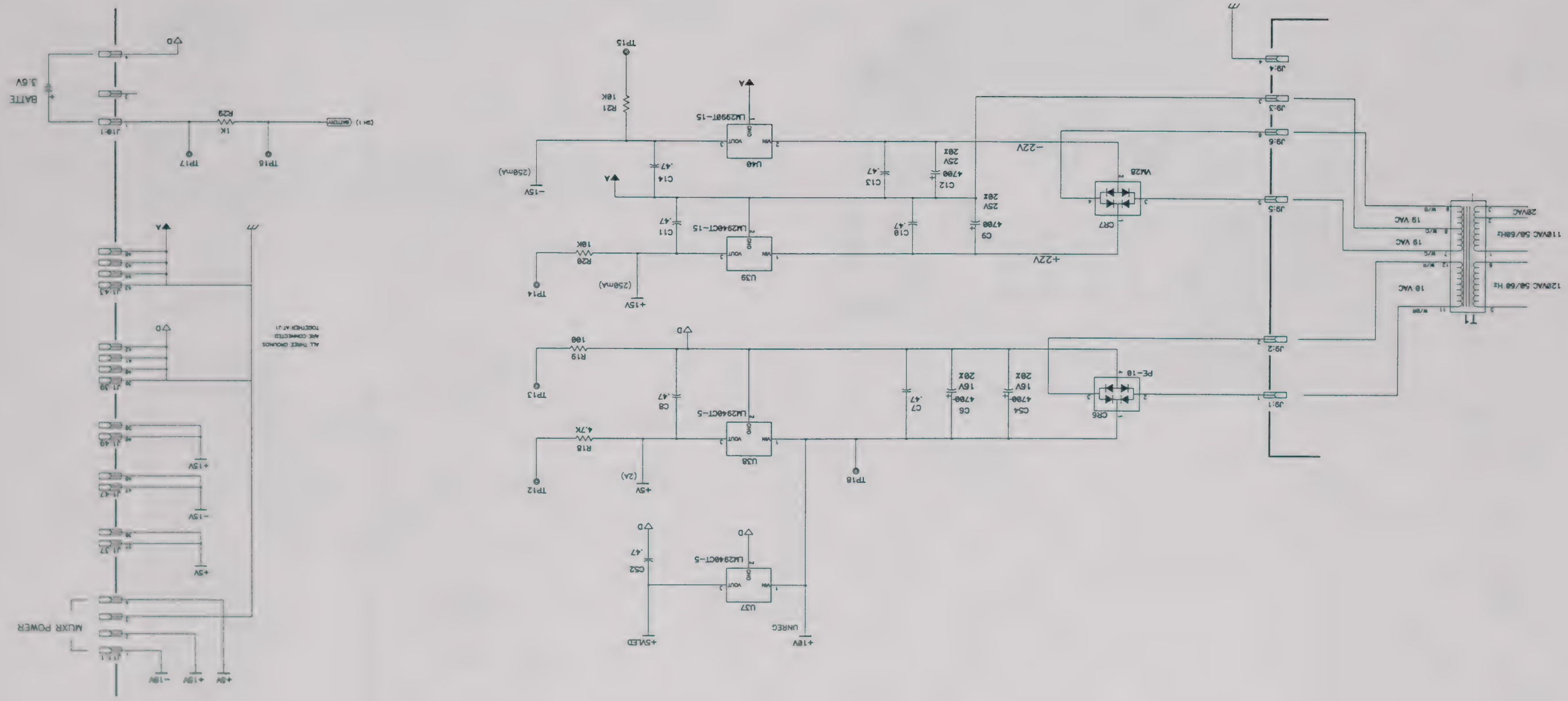


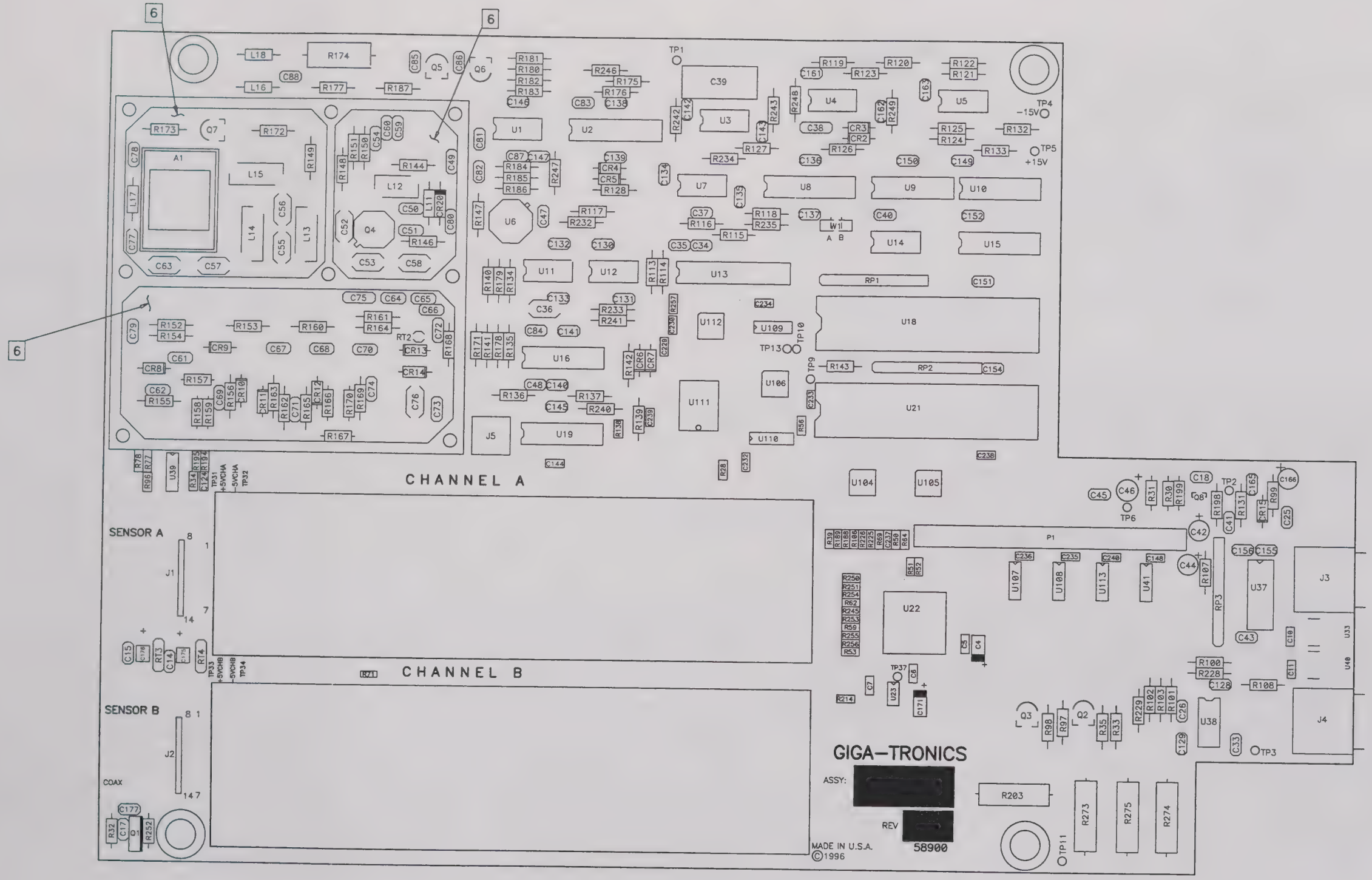




CPU Circuit Schematic (A1)
DWG# 21694 Rev G
Sheet 2 of 3
8-10

CPU Circuit Schematic (A1)
DWG# 21694 Rev G
Sheet 3 of 3
8-11

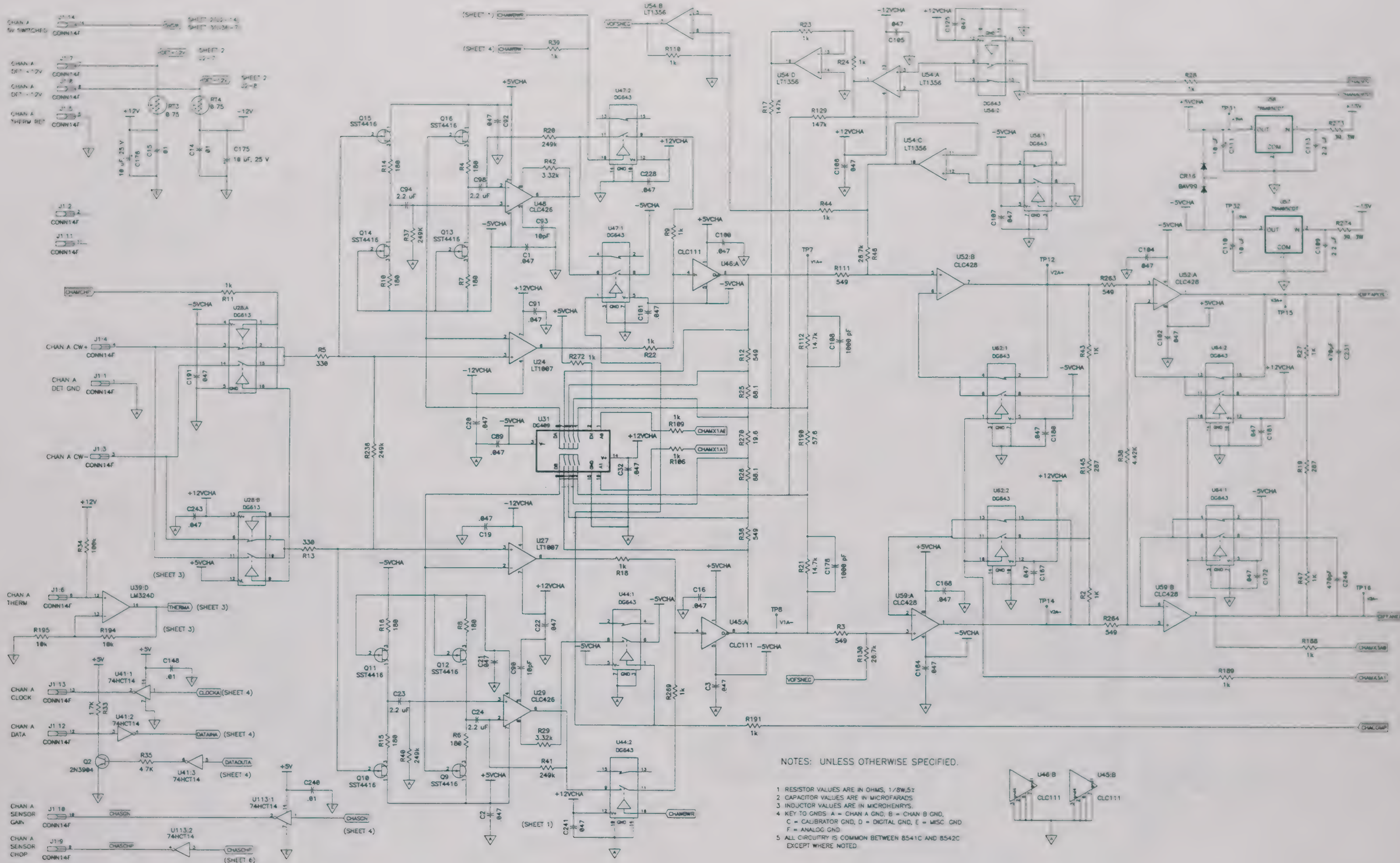




NOTE: See Detail Drawing on Sheet 2 for Reference Designators on both channels A and B.

NOTE: DWG# 30164 applies to Model 8541C (includes Channel A only).
DWG# 30173 applies to Model 8542C (includes Channels A and B).

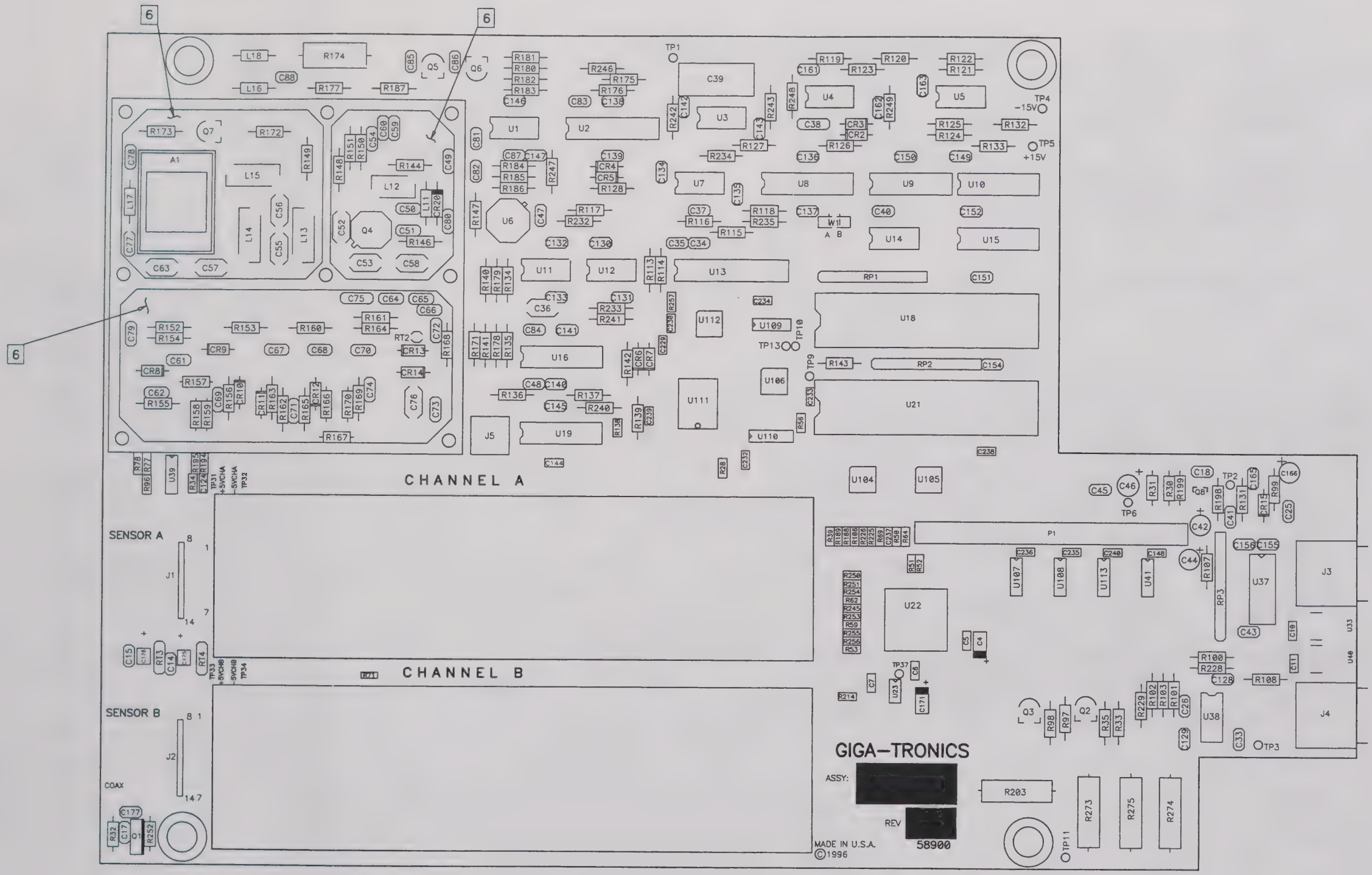
Analog PC Assy (A2)
DWG# 30173 Rev L
Sheet 1 of 2
8-12



NOTES: UNLESS OTHERWISE SPECIFIED.

1. RESISTOR VALUES ARE IN OHMS, 1/8W,5%
2. CAPACITOR VALUES ARE IN MICROFARADS
3. INDUCTOR VALUES ARE IN MICROHENRYS.
4. KEY TO GNDS: A = CHAN A GND, B = CHAN B GND, C = CALIBRATOR GND, D = DIGITAL GND, E = MISC. GND F = ANALOG GND
5. ALL CIRCUITRY IS COMMON BETWEEN 8541C AND 8542C EXCEPT WHERE NOTED

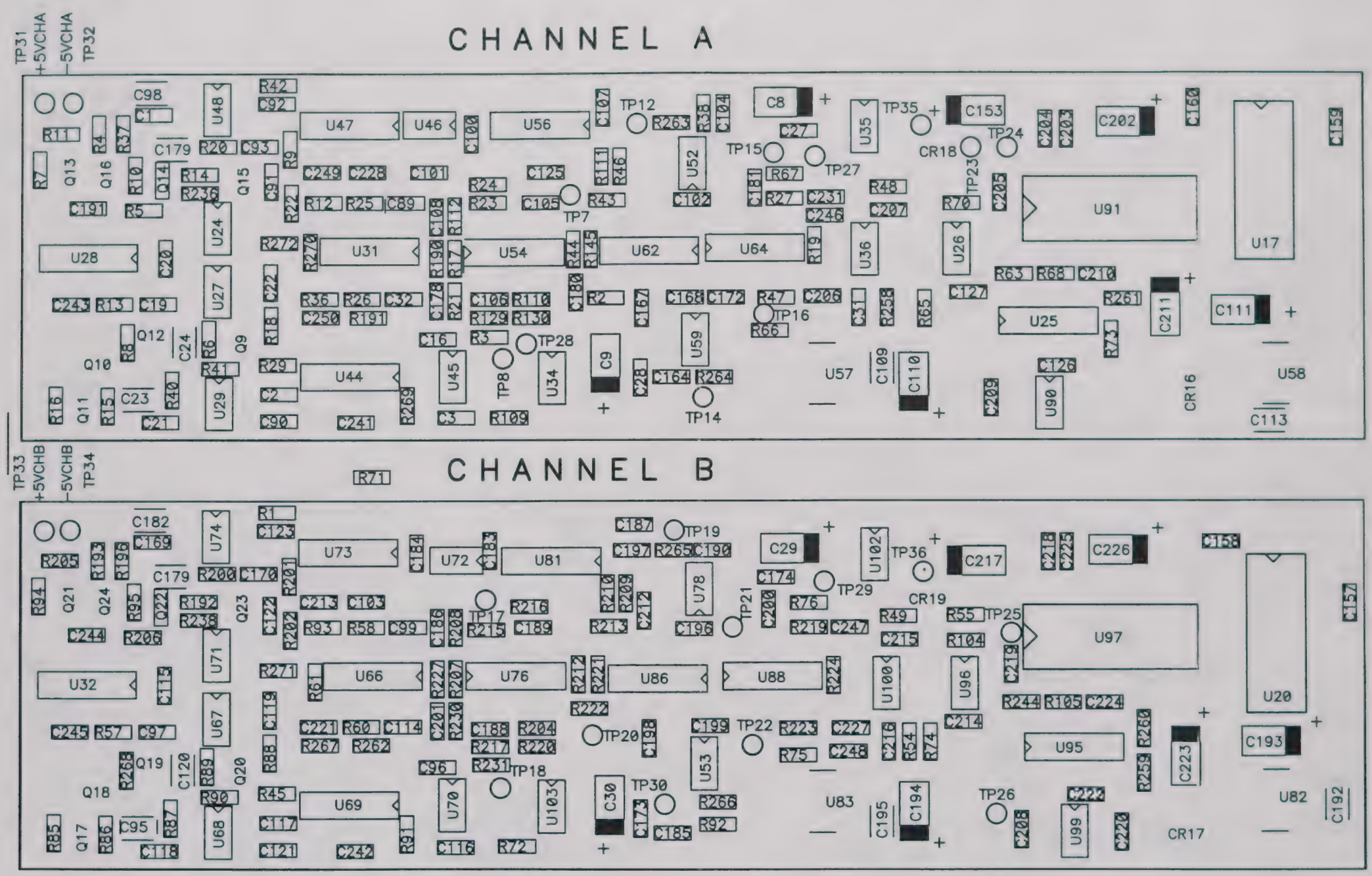
Analog Circuit Schematic (A2)
DWG# 30165 Rev J
Sheet 1 of 6
8-14



NOTE: See Detail Drawing on Sheet 2 for Reference Designators on both channels A and B.

NOTE: DWG# 30164 applies to Model 8541C (includes Channel A only).
DWG# 30173 applies to Model 8542C (includes Channels A and B).

Analog PC Assy (A2)
DWG# 30173 Rev L
Sheet 1 of 2
8-12


CHANNEL A
CHANNEL B
TP31
+5VCHA
-5VCHA
TP32
TP33
-5VCHB
+5VCHB
TP34
U47
U46
U56
U48
U31
U54
U62
U64
U28
U24
U27
U44
U45
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TP12
TP35
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TP7
TP16
TP28
TP8
TP14
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TP36
TP29
TP21
TP17
TP25
TP20
TP22
TP18
TP30
TP26
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CR16
CR17
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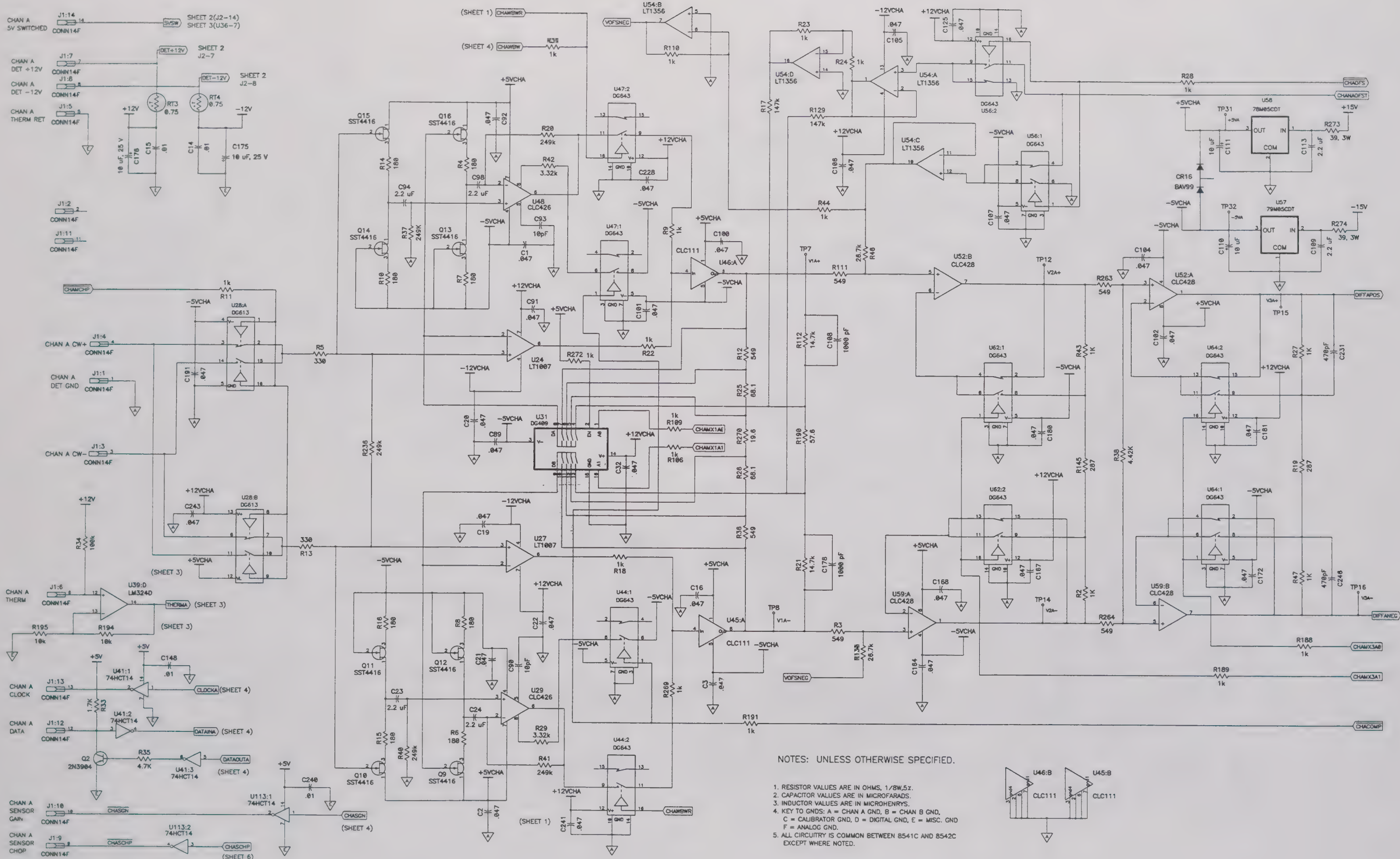


NOTES: UNLESS OTHERWISE SPECIFIED.

1. RESISTOR VALUES ARE IN OHMS, 1/8W,5%.
2. CAPACITOR VALUES ARE IN MICROFARADS.
3. INDUCTOR VALUES ARE IN MICROHENRYS.
4. KEY TO GNDS: A = CHAN A GND, B = CHAN B GND, C = CALIBRATOR GND, D = DIGITAL GND, E = MISC. GND F = ANALOG GND.
5. ALL CIRCUITRY IS COMMON BETWEEN 8541C AND 8542C EXCEPT WHERE NOTED.

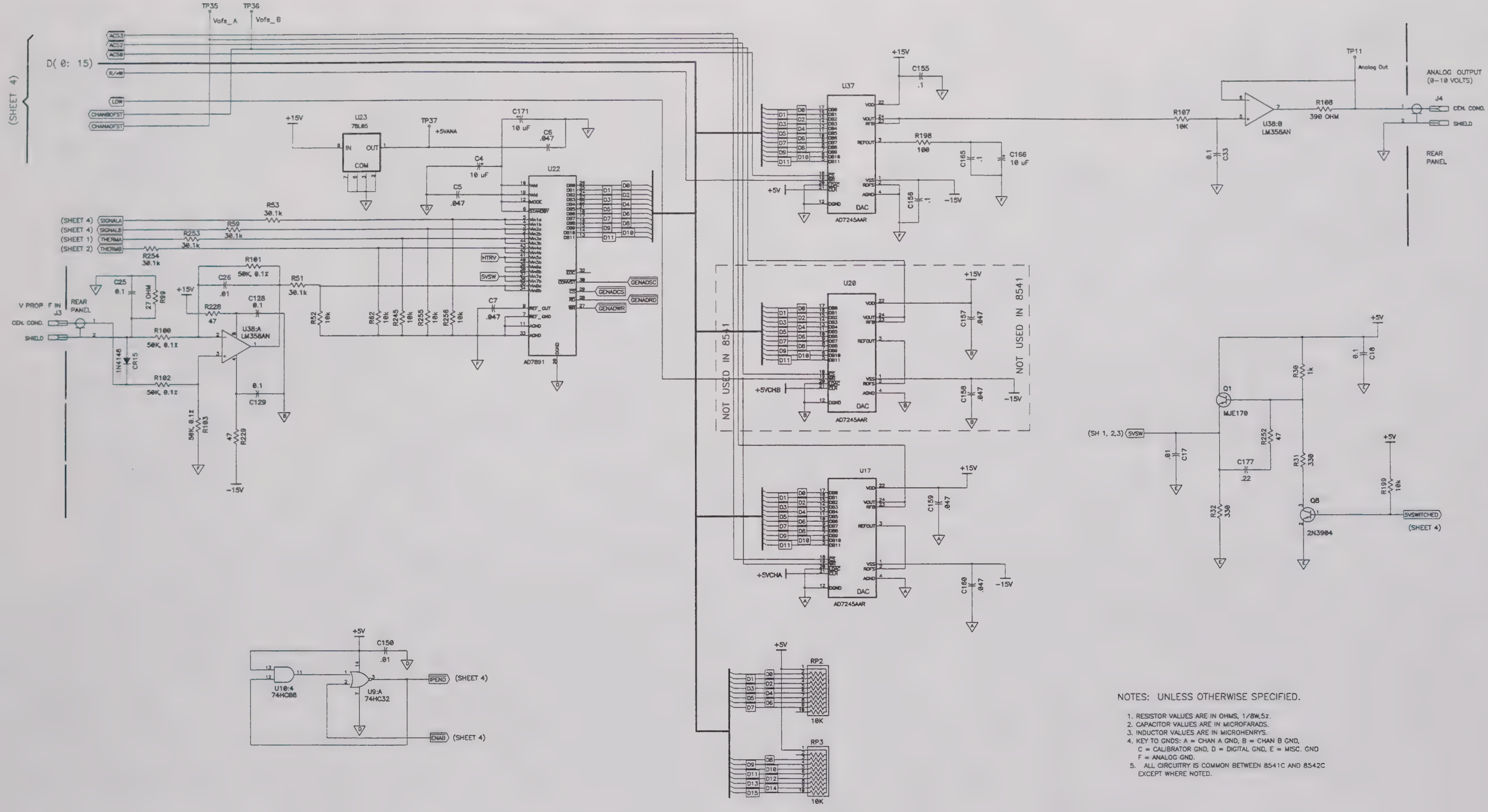
Analog Circuit Schematic (A2)
DWG# 30165 Rev J
Sheet 1 of 6
8-14

NOT USED ON 8541C

NOTES: UNLESS OTHERWISE SPECIFIED.

1. RESISTOR VALUES ARE IN OHMS, 1/8W,5%
2. CAPACITOR VALUES ARE IN MICROFARADS.
3. INDUCTOR VALUES ARE IN MICROHENRYS
4. KEY TO GNDS: A = CHAN A GND, B = CHAN B GND, C = CALIBRATOR GND, D = DIGITAL GND, E = MISC GND, F = ANALOG GND
5. ALL CIRCUITRY IS COMMON BETWEEN 8541C AND 8542C EXCEPT WHERE NOTED.

Analog Circuit Schematic (A2)
DWG# 30165 Rev J
Sheet 2 of 6
8-15



NOTES: UNLESS OTHERWISE SPECIFIED.

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5. ALL CIRCUITRY IS COMMON BETWEEN 8541C AND 8542C EXCEPT WHERE NOTED.

Analog Circuit Schematic (A2)
DWG# 30165 Rev J
Sheet 3 of 6
8-16

Analog Circuit Schematic (A2)

DWG# 30165 Rev J

Sheet 4 of 6

NOTES: UNLESS OTHERWISE SPECIFIED.

1. RESISTOR VALUES ARE IN OHMS, 1/8W,5%
2. CAPACITOR VALUES ARE IN MICROFARADS
3. INDUCTOR VALUES ARE IN MICROHENERYS.
4. KEY TO CNDS: A = CHAN A GND, B = CHAN B GND, C = CALIBRATOR GND, D = DIGITAL GND, E = MISC GND F = ANALOG GND
5. ALL CIRCUITRY IS COMMON BETWEEN 8541C AND 8542C EXCEPT WHERE NOTED

DIGITAL GND

ANALOG GND

SHEETS 1 AND 3

(SHEET 5)

(SHEET 3 & 6)

D(0: 15)
(SHEET 3)

(SHEET 1 & 5)

(0 TO -0.8V)

(0 -10V)

SAMPLE

QUIESCENT

COMPENSATE

LIMIT

HIGAIN/LIMIT

LOWGAIN

HIGAIN

PASSWORD

DISABLE

ENABLE

JWPR-2POS

DC4110

DC4111

74HC00

74HC02

74HC04

74HC32

74HC86

74HC88

LM324

LM339

LM4250

LM4562

LM6135

AD7524

AD7545

AD7574

AD7575

AD7581

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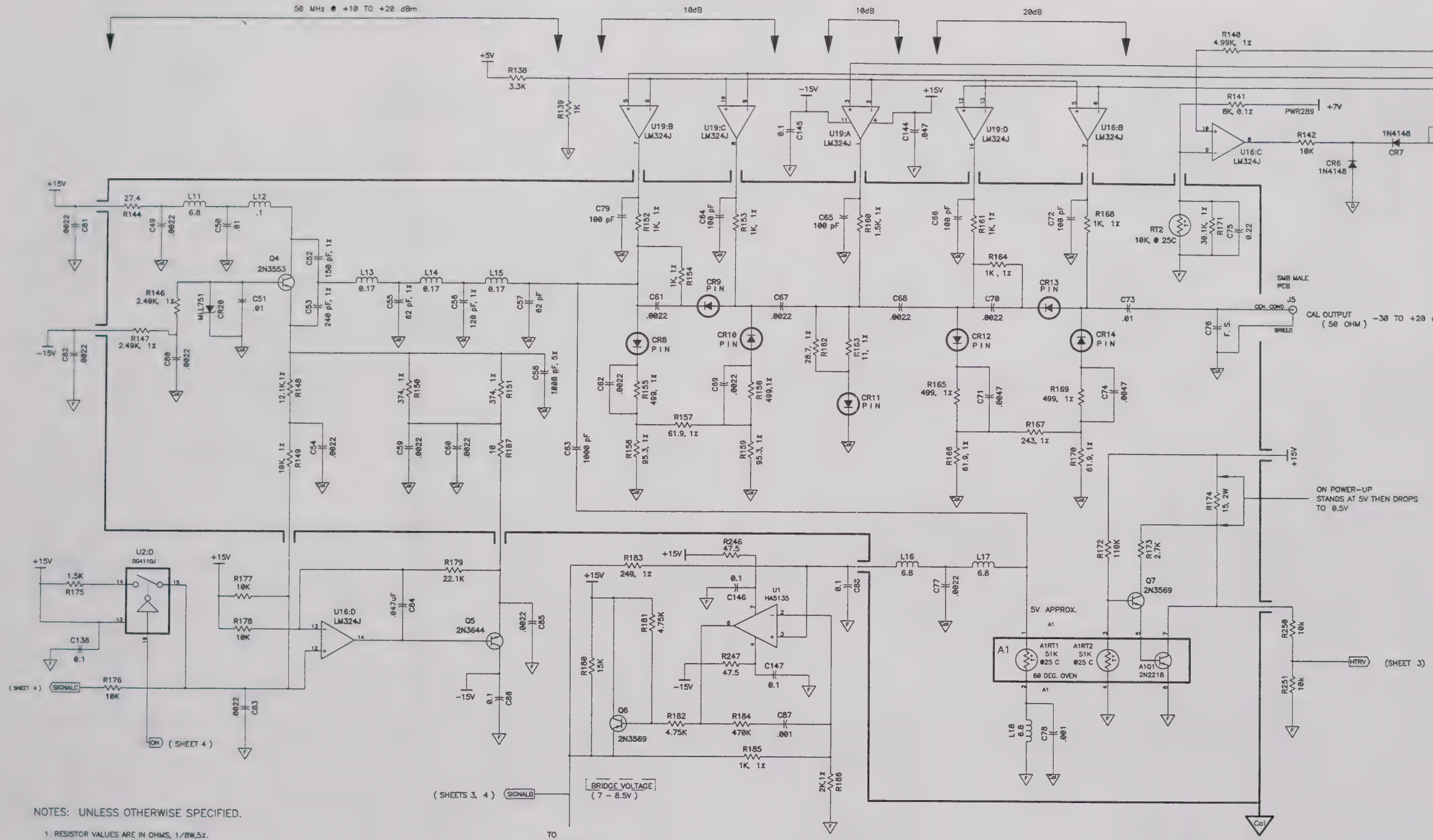

NOTES: UNLESS OTHERWISE SPECIFIED.

1. RESISTOR VALUES ARE IN OHMS, 1/8W, 5%.
2. CAPACITOR VALUES ARE IN MICROFARADS.
3. INDUCTOR VALUES ARE IN MICROHENRYS.
4. KEY TO GNDS: A = CHAN A GND, B = CHAN B GND, C = CALIBRATOR GND, D = DIGITAL GND, E = MISC. GND F = ANALOG GND
5. ALL CIRCUITRY IS COMMON BETWEEN 8541C AND 8542C EXCEPT WHERE NOTED

Analog Circuit Schematic (A2)
DWG# 30165 Rev J
Sheet 5 of 6
8-18

Analog Circuit Schematic (A2)
DWG# 30165 Rev J
Sheet 6 of 6
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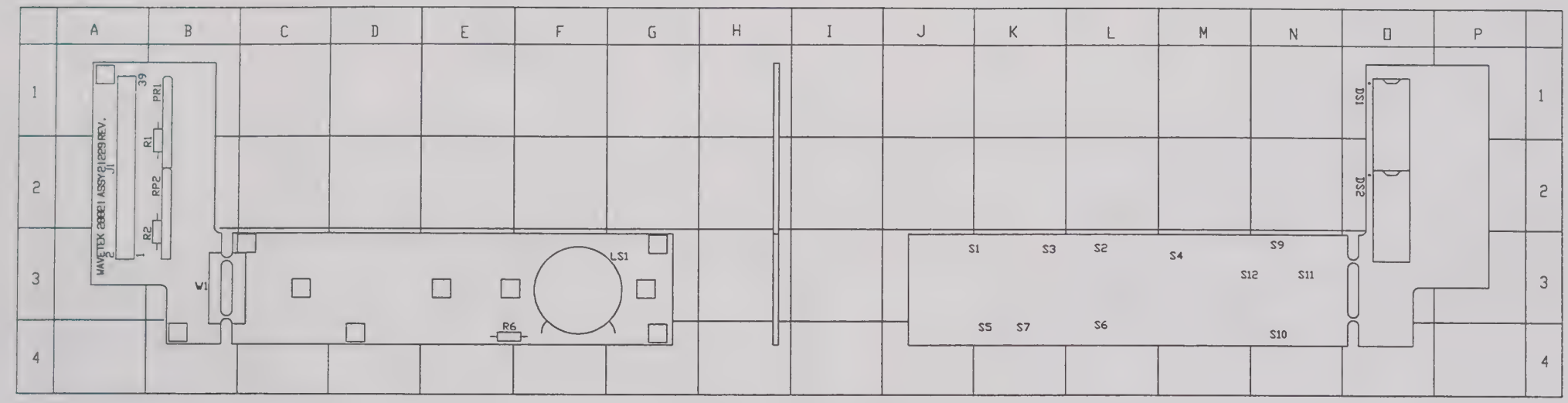
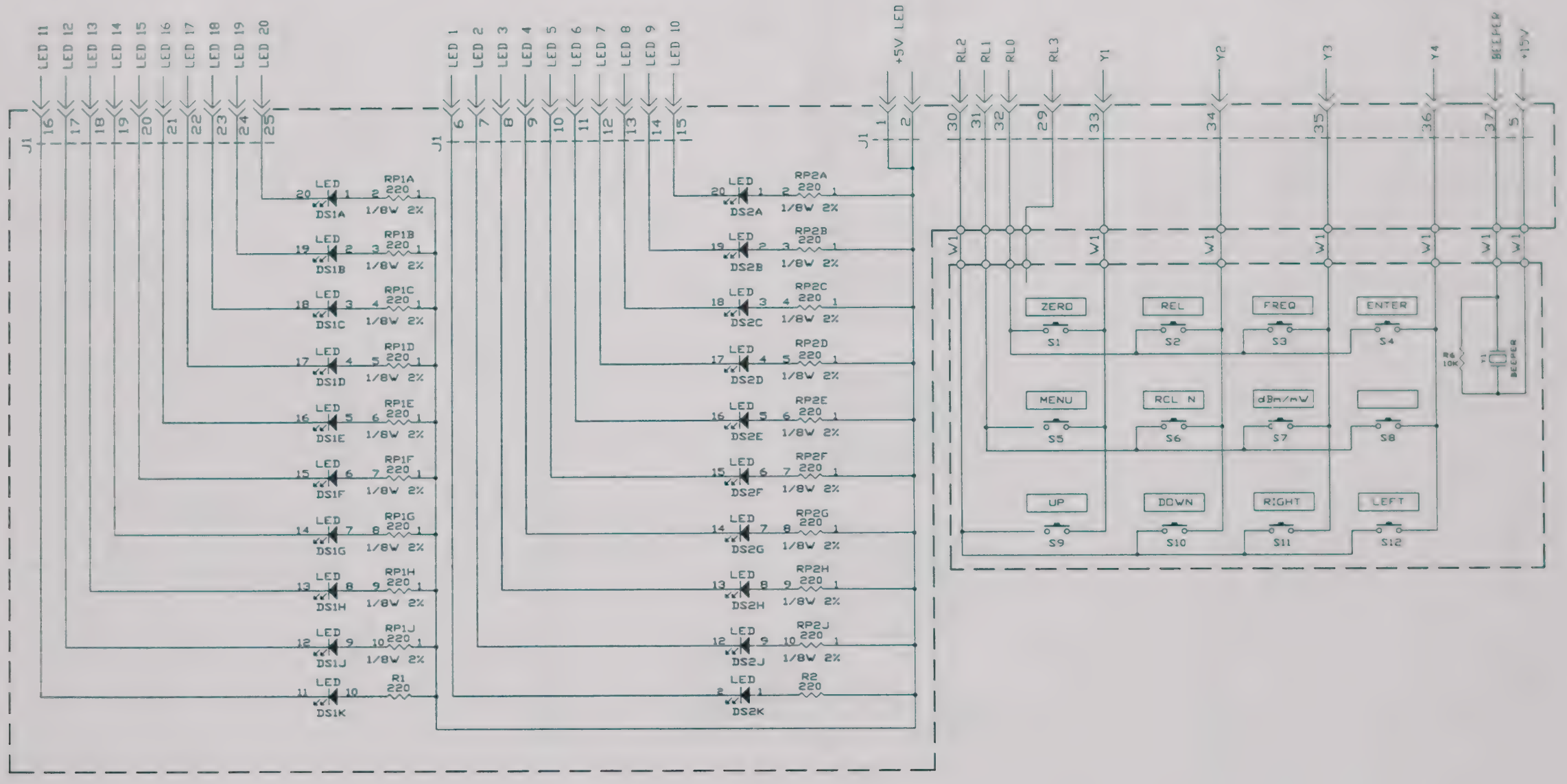


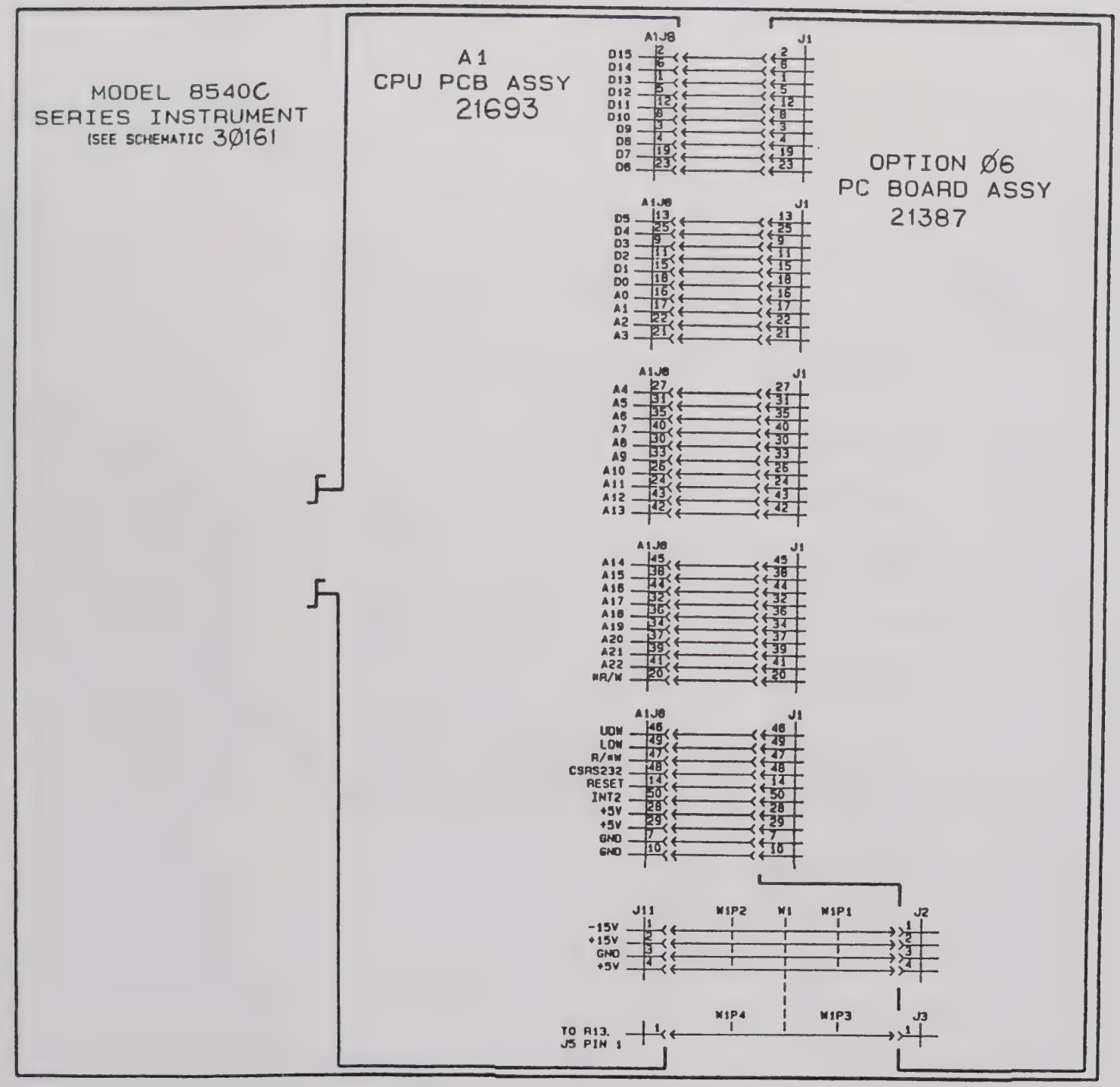
FRONT PANEL PCB ASSEMBLY #21229

COMPONENT LOCATION TABLE					
CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC
DS1	D-1	LS1	F-3/	RP1	B-1
DS2	D-2		G-3	RP2	B-2
J1	A-2	R1	B-2	W1	B-3
		R2	B-3		
		R6	E-4		

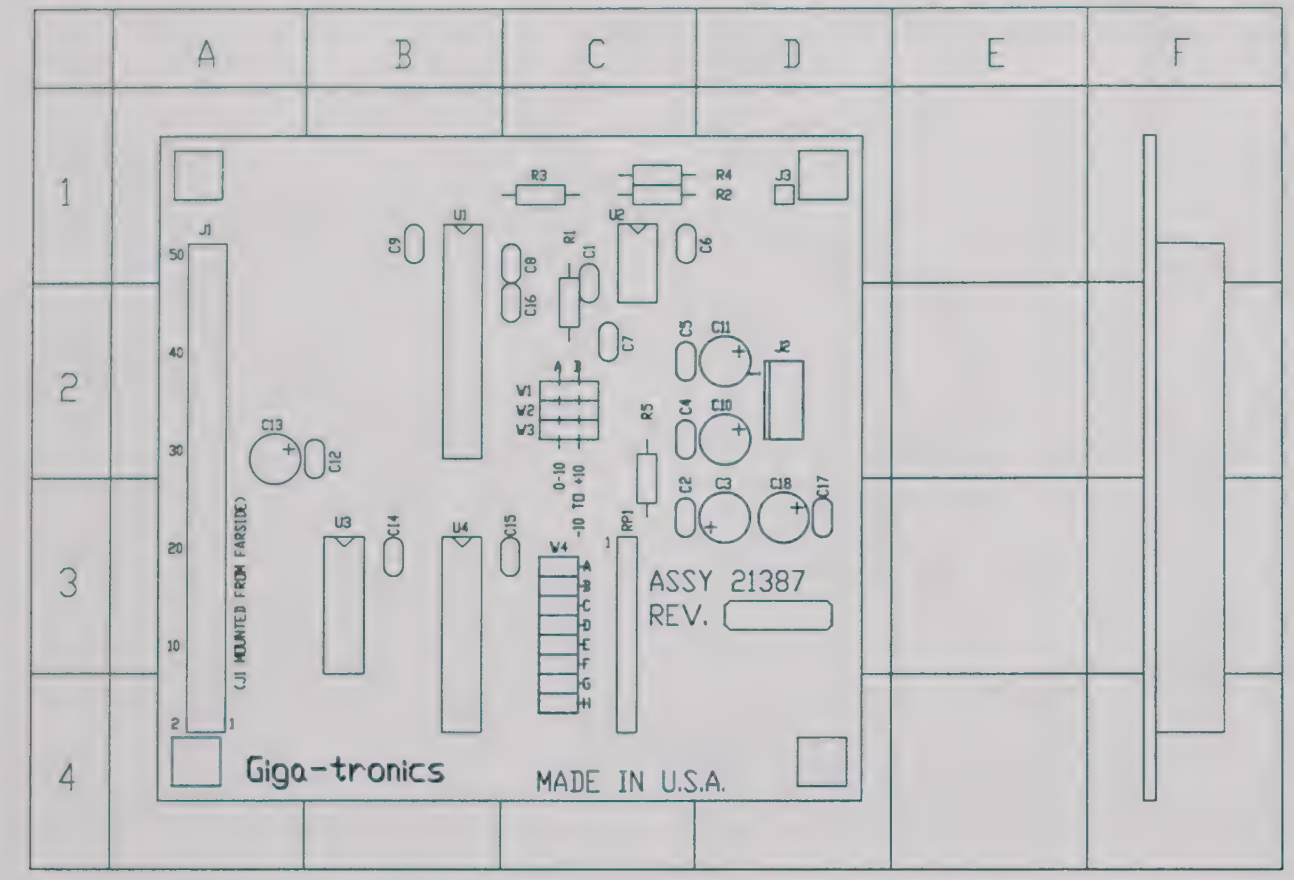
Front Panel PC Assy (A3)
DWG# 21229 Rev C
Sheet 1 of 1
8-20



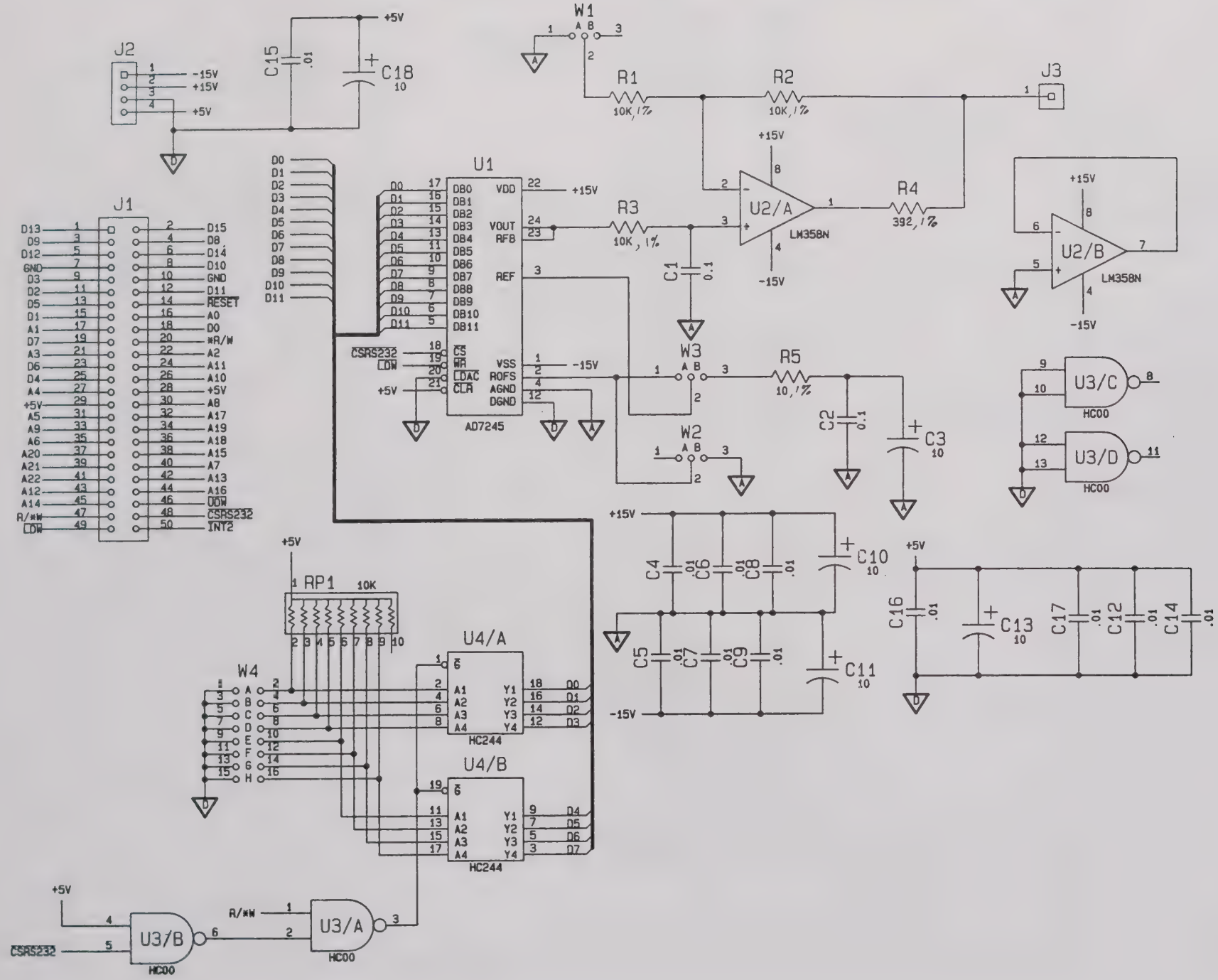
Front Panel Circuit Schematic (A3)
DWG# 21230 Rev C
Sheet 1 of 1
8-21



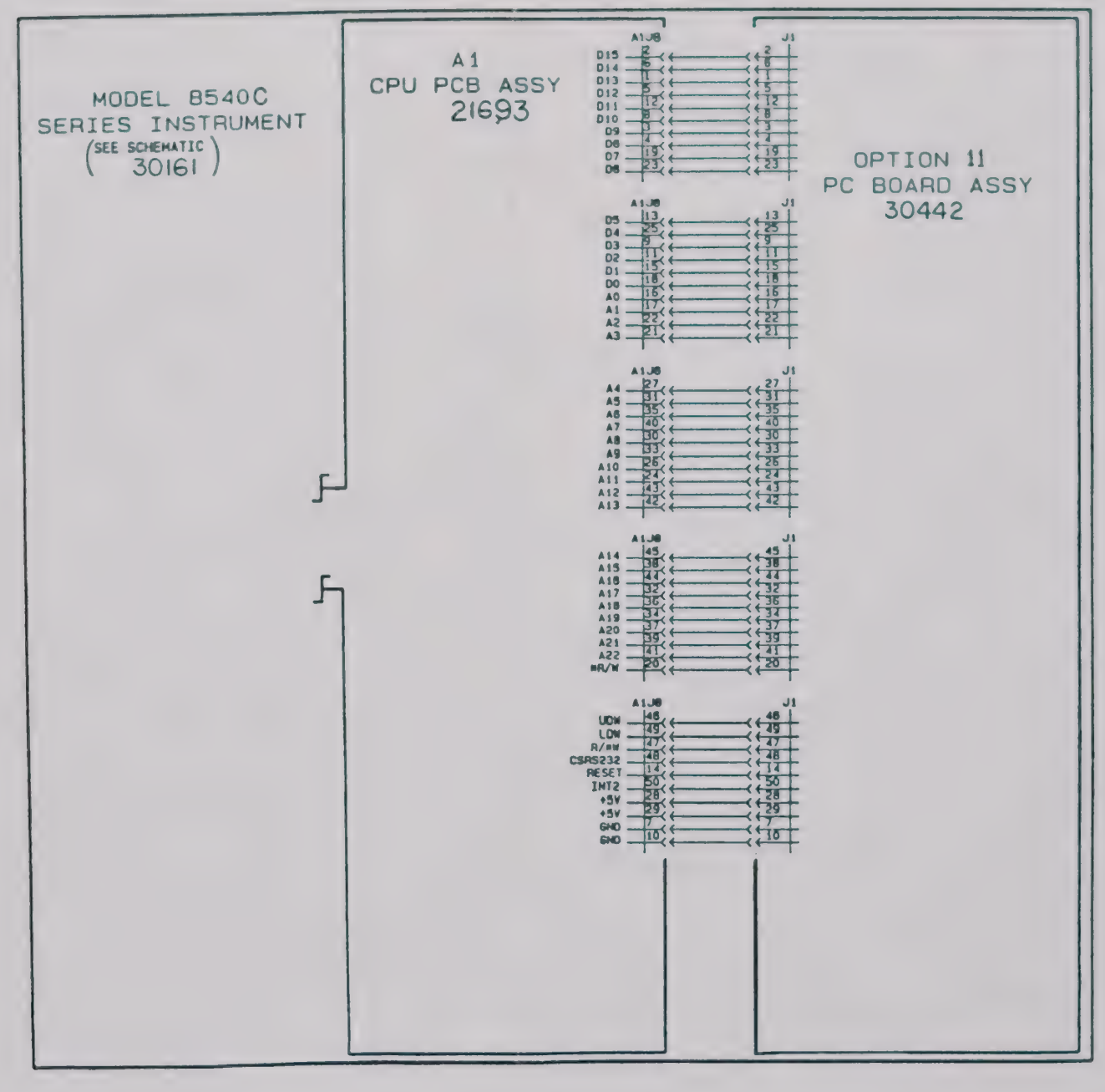
8542C Option 06 System Schematic
DWG# 30535 Rev B
Sheet 1 of 1

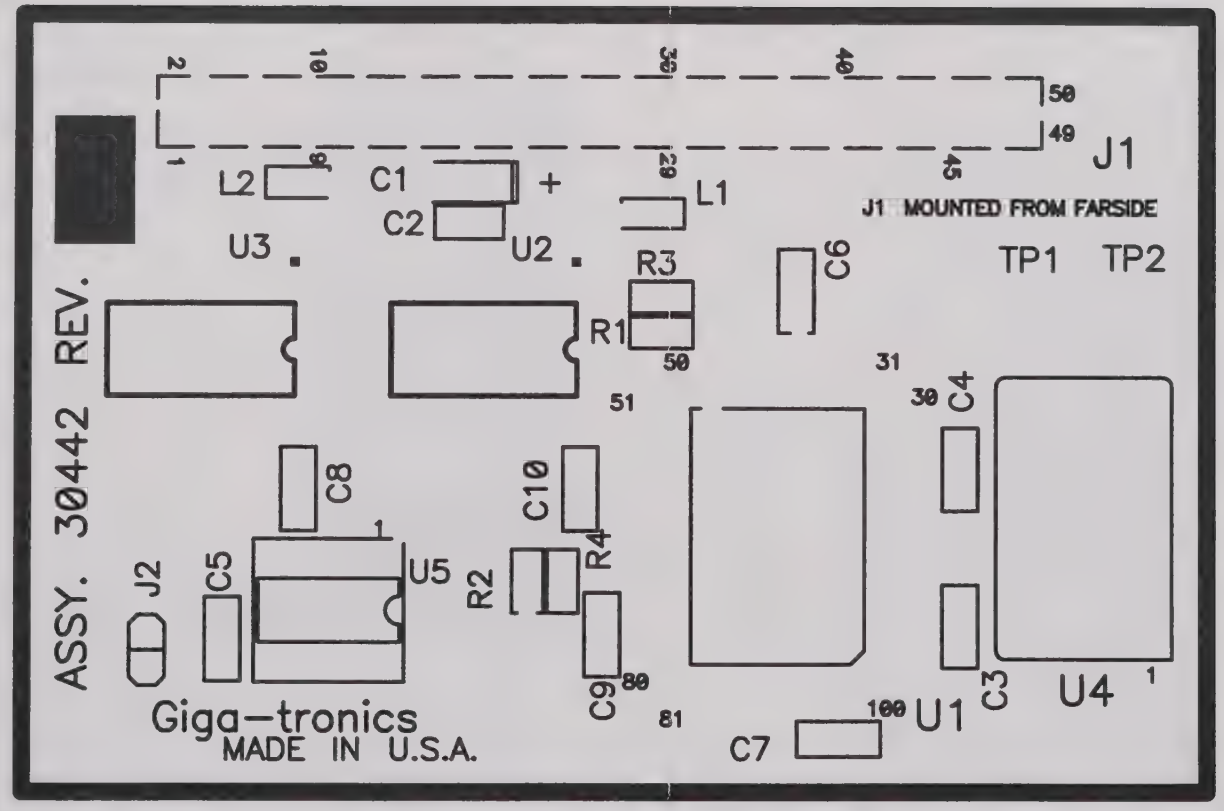


COMPONENT LOCATION TABLE							
CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC
C1	C1	C13	A2	J2	D2	U1	B1
C2	C3	C14	B3	J3	D1	U2	C1
C3	D3	C15	C3			U3	B3
C4	C2	C16	C3			U4	B3
C5	C2	C17	D2	R1	C1		
C6	C1	C18	D3	R2	C1		
C7	C2			R3	C1	W1	C2
C8	C1	J1	A1/	R4	C1	W2	C2
C9	B1		A2/	R5	C2	W3	C2
C10	D2		A3/			W4	C3
C11	D2		A4				
C12	B2			RP1	C3		

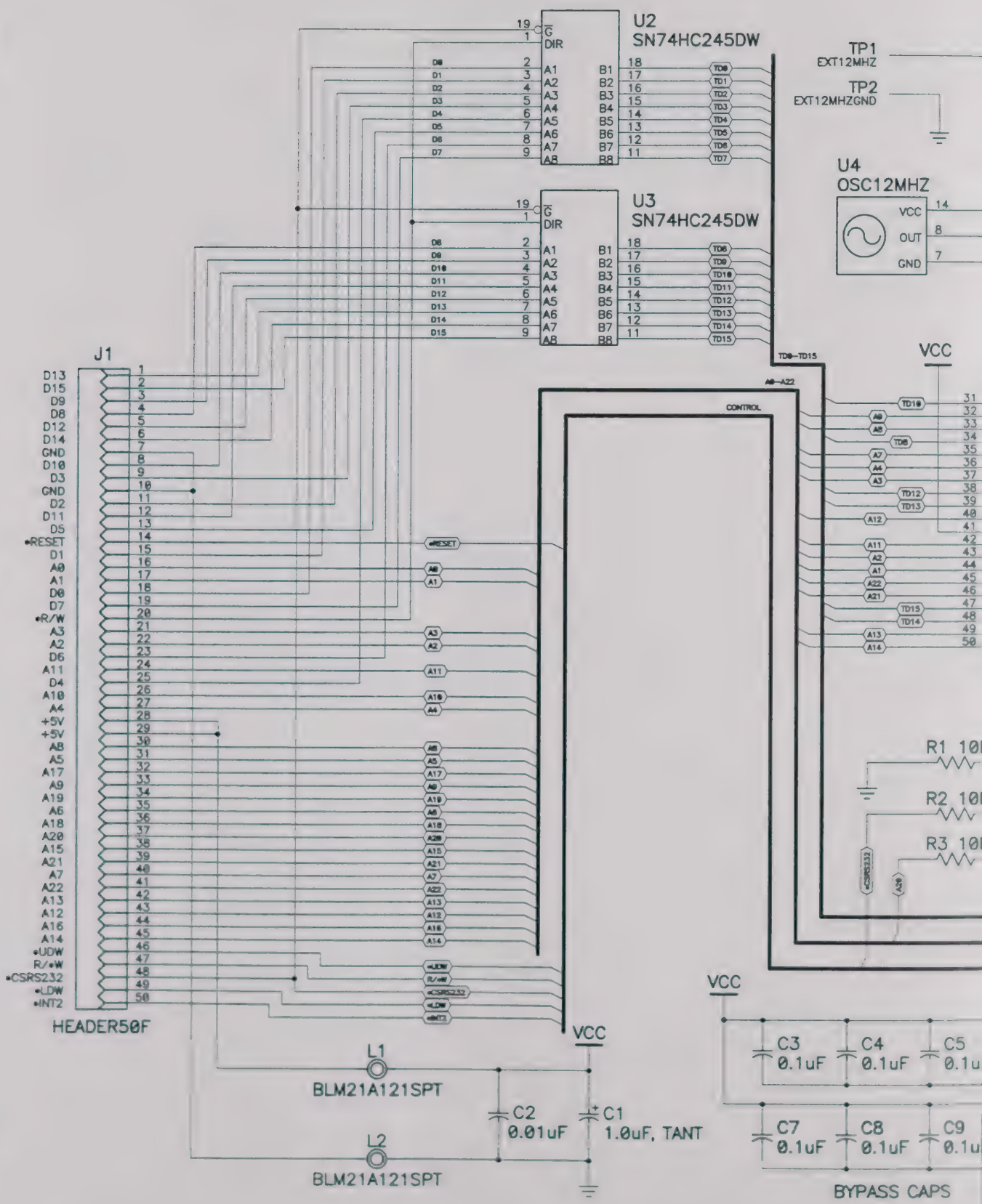


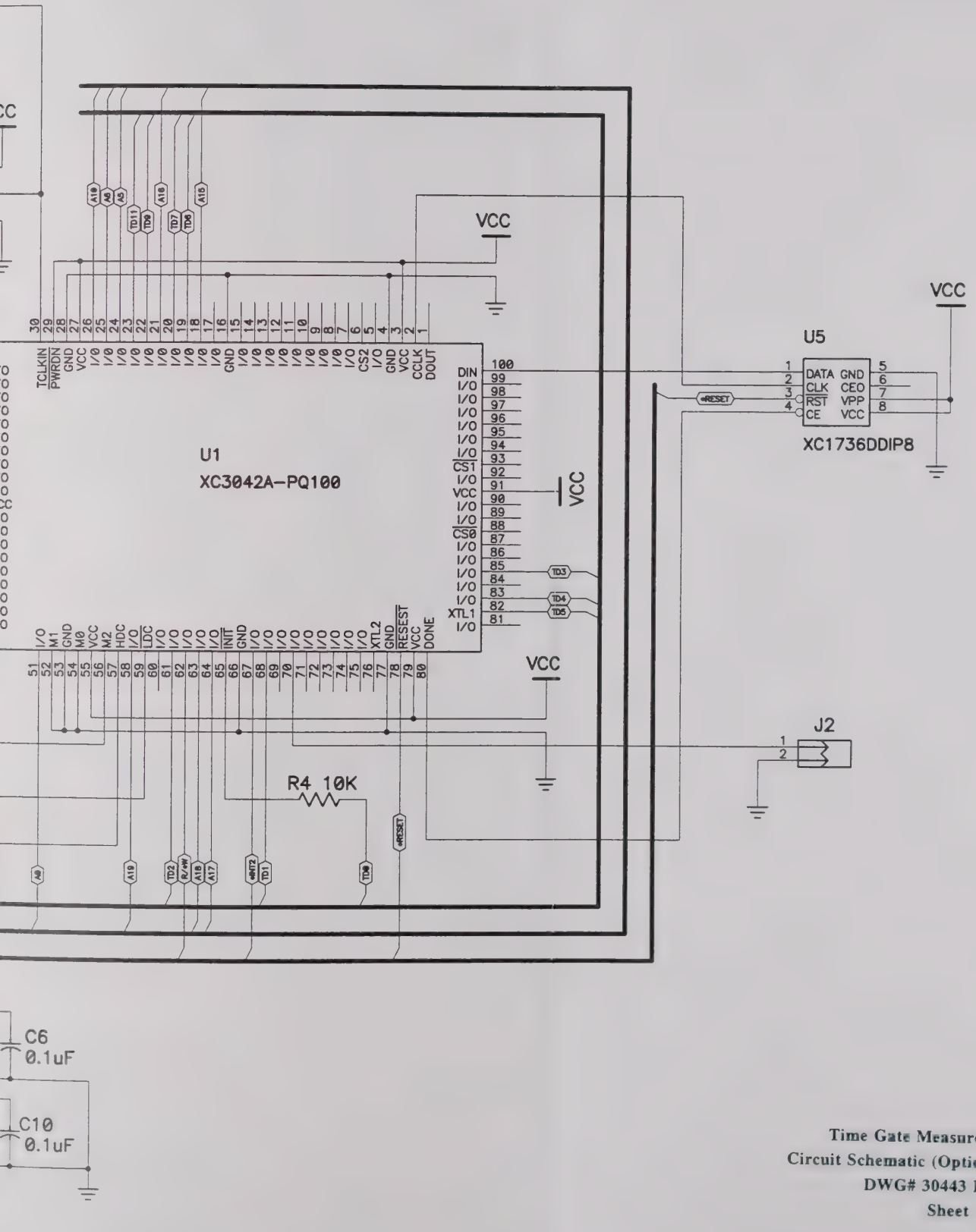
Option 06 Circuit Schematic
DWG# 21388 Rev A
Sheet 1 of 1
8-24


MODEL 8540C
SERIES INSTRUMENT
(SEE SCHEMATIC 30161)
A1
CPU PCB ASSY
21693
OPTION 11
PC BOARD ASSY
30442
A1J8
J1
D15 2 2
D14 6 6
D13 1 1
D12 5 5
D11 12 12
D10 8 8
D09 3 3
D08 4 4
D07 19 19
D06 23 23
D05 13 13
D04 25 25
D03 9 9
D02 11 11
D01 15 15
D00 18 18
A0 16 16
A1 17 17
A2 22 22
A3 21 21
A4 27 27
A5 31 31
A6 35 35
A7 40 40
A8 30 30
A9 33 33
A10 26 26
A11 24 24
A12 43 43
A13 42 42
A14 45 45
A15 38 38
A16 44 44
A17 32 32
A18 36 36
A19 34 34
A20 37 37
A21 39 39
A22 41 41
#R/W 20 20
UDW 48 48
LDW 49 49
R/#W 47 47
CSRS232 46 46
RESET 14 14
INT2 50 50
+5V 28 28
+5V 29 29
GND 7 7
GND 10 10



Time Gate Measurement PC Assy
(Option 11)
DWG# 30442 Rev B
Sheet 1 of 1
8-26


U2
SN74HC245DW
U3
SN74HC245DW
U4
OSC12MHZ
TP1
EXT12MHZ
TP2
EXT12MHZGND
J1
HEADER50F
VCC
L1
BLM21A121SPT
L2
BLM21A121SPT
C1
1.0uF, TANT
C2
0.01uF
C3
0.1uF
C4
0.1uF
C5
C7
0.1uF
C8
0.1uF
C9
BYPASS CAPS
R1 10
R2 10
R3 10
CONTROL



Time Gate Measurement
Circuit Schematic (Option 11)
DWG# 30443 Rev B
Sheet 1 of 1

A

Typical Applications Programs

A.1 Continuous Data Reading

```
    OUTPUT 713;TR3              ! set freerun mode
Main:
    ENTER 713;Reading           ! make reading
    PRINT Reading
    GO TO MAIN
```

A.2 Remote Calibration of a Sensor

```
    OUTPUT 713;PR               ! preset the instrument to a known state
    OUTPUT 713;LG               ! set Log units (dB or dBm)
    OUTPUT 713;AP               ! Measure sensor A
Main:                           ! start of measurement loop
    OUTPUT 713;TR2              ! Trigger full measurement with settling
    ENTER 713;Reading           ! Read the data over the bus into variable N
    PRINT Reading
    GO TO Main
Calibrate                       ! calibration routine
ON INTR 7 GOSUB Srq_interrupt   ! setup serial poll interrupt jump location
ENABLE INTR 7;2                 ! enable SRQ interrupts
OUTPUT 713;*SRE002              ! set service request mask to 2
OUTPUT 713;CS                   ! clear status byte
OUTPUT 713;CLEN                 ! start calibration
Flag=0                          ! reset control flag
WHILE Flag=0                    ! wait while calibrating
END WHILE
RETURN
Srq_interrupt:                  ! SRQ interrupts jump here
IF BIT(State, 1) THEN
   PRINT GOOD CAL
   ELSE
        IF BIT(State, #) THEN
            PRINT BAD CAL
            ENDIF
ENDIF
OUTPUT 713;CS                   ! clear status byte
Flag=1                          ! set control flag true
RETURN
```

A.3 Speed Tests: Normal and Swift

```
CSUB    PROG 494 RE-STORE WSPEED
11      ! SPEED TESTS FOR THE GIGA-TRONICS 8542
12      ! 2/7/92
20      Giga-tronics=713
30      DIM A(100) ,B(100)
31      OUTPUT Giga-tronics;PRLGOC1
32      OUTPUT Giga-tronics;AEFM0EN
34      OUTPUT Giga-tronics;DU GIGA-TRONICS 8542 SPEED TESTS
35      WAIT 1
36      OUTPUT Giga-tronics;DUUN-PLUG B SENSOR
37      PRINT
40      PRINT GIGA-TRONICS 8542 SPEED TESTS
60      PRINT CONNECT A SENSOR ONLY. NO B SENSOR
61      PRINT PRESS RETURN WHEN READY
70      INPUT A$
71      OUTPUT Giga-tronics;DE
80      !
90      PRINT
100     PRINT NORMAL TR3 TRIGGER MODE SINGLE CHANNEL
110     GOSUB Timeloop1
111     !
112     PRINT
113     PRINT NORMAL TR2 TRIGGER MODE SINGLE CHANNEL
114     GOSUB Timeloop4
120     !
130     OUTPUT Giga-tronics;SWIFT FREERUN
140     WAIT 1
150     PRINT
160     PRINT SWIFT MODE SINGLE CHANNEL
170     GOSUB Timeloop2
180     OUTPUT Giga-tronics;SWIFT OFF
181     !
190     PRINT
200     PRINT END OF SINGLE CHANNEL MODE
210     PRINT CONNECT B SENSOR FOR NEXT SET OF TESTS
211     PRINT PRESS RETURN WHEN READY
212     OUTPUT Giga-tronics;DUCONNECT B SENSOR
220     INPUT A$
221     OUTPUT Giga-tronics;DE
223     !
230     PRINT
240     PRINT NORMAL TR3 TRIGGER MODE TWO CHANNELS
250     GOSUB Timeloop3
251     !
260     PRINT
270     PRINT SWIFT MODE DUAL CHANNEL
280     OUTPUT Giga-tronics;SWIFT FREERUN
290     WAIT 1
300     GOSUB Timeloop2
310     PRINT
320     OUTPUT Giga-tronics;SWIFT OFF
330     PRINT END OF TESTS
340     STOP
```

[continued...]

```
350     !
360     Timeloop1:   ! SINGLE CHANNEL MEASUREMENTS
370          T1=TIMEDATE
380          FOR I=1 TO 100
390          ENTER Giga-tronics;A(I)
400     !    PRINT A(I)
410          NEXT I
420          T2=TIMEDATE
430          PRINT 100/(T2-T1);PER SECOND
440     !    FOR I=1 TO 100
450     !    PRINT A(I)
460     !    NEXT I
470     !    PRINT
480          RETURN
490     !
500     Timeloop2:   ! TWO CHANNELS IN SWIFT MODE
510          T1=TIMEDATE
520          FOR I=1 TO 100
530          ENTER Giga-tronics;A(I),B(I)
540          NEXT I
550          T2=TIMEDATE
560          PRINT 100/(T2-T1);PER SECOND FOR BOTH CHANNELS
570          RETURN
580          !
590     Timeloop3:   !
600          T1=TIMEDATE
610          FOR I=1 TO 100
620          OUTPUT Giga-tronics;AP
630          ENTER Giga-tronics;A(I)
640          OUTPUT Giga-tronics;BP
650          ENTER Giga-tronics;B(I)
660          NEXT I
670          T2=TIMEDATE
680          PRINT 100/(T2-T1);PER SECOND BOTH CHANNELS
690          OUTPUT Giga-tronics;AP
700          RETURN
701     !
702     Timeloop4:   !
703          T1=TIMEDATE
704          FOR I=1 TO 100
705          OUTPUT Giga-tronics;TR2
706          ENTER Giga-tronics;A(I)
709          NEXT I
710          T2=TIMEDATE
711          PRINT 100/(T2-T1);PER SECOND SINGLE CHANNEL
712          OUTPUT Giga-tronics;TR3
713          RETURN
714          END
```

A.4 Swift Demo 1: FREERUN

```
10      ! RE-STORE SWIFT
20      !
30      ! DEMO PROGRAM FOR 8540C SWIFT MODE
40      !
50      ! 2/13/92
60      !
70      Giga-tronics=713
80      N=100
90      OPTION BASE 1
110         REAL Nums(100)
120         OUTPUT Giga-tronics;PRLG
130         OUTPUT Giga-tronics;SWIFT FREERUN
140         WAIT .5
145         WINDOW 1 ,N,-70,20
150     Mainloop
151         FOR I=1 TO N
170         ENTER Giga-tronics;Nums(I)
180         NEXT I
190         GCLEAR
200         PEN 2
210         GRID 10,10
220         PEN 1
230         MOVE 1 ,Nums(I)
240         FOR I=1 TO N
250             DRAW I ,Nums (I)
260         NEXT I
270     GOTO Mainloop
280         OUTPUT Giga-tronics;SWIFT OFF
300         END
```

A.5 Swift Demo 2: GET

```
10      ! RE-STORE SWIFT
20      ! DEMO PROGRAM FOR 8540C SWIFT MODE
40      !
50      ! 2/13/92
60      !
70      Giga-tronics=713
80      N=100
90      OPTION BASE 1
110         REAL Nums(100)
120         OUTPUT Giga-tronics;PRLG
130         OUTPUT Giga-tronics;SWIFT GET;N
140         WAIT .5
145         WINDOW 1,N-70,20
150     Mainloop
151         FOR I=1 TO N
160         TRIGGER Giga-tronics
161         NEXT I
170         ENTER Giga-tronics;Nums(*)
190         GCLEAR
200         PEN 2
210         GRID 10,10
220         PEN 1
230         MOVE 1,Nums(1)
240         FOR I=1 TO N
250             DRAW I,Nums(I)
260         NEXT I
270     GOTO Mainloop
280         OUTPUT Giga-tronics;SWIFT OFF
300     END
```

A.6 Fast Buffered Demo: POST GET

```
10      ! RE-STORE FAST BUFFERED
20      !
30      ! DEMO PROGRAM FOR 8540C FAST BUFFERED MODE
40      !
50      ! 2/13/92
60      !
70      Giga-tronics=713
80      N=100
90T     OPTION BASE 1
110         REAL Nums(100)
120         OUTPUT Giga-tronics;PRLG
130         OUTPUT Giga-tronics;FBUF POST GET BUFFER;N
140         WAIT .5
145         WINDOW 1,N,-70,20
150     Mainloop
152         Wait .05
160         TRIGGER Giga-tronics
170         ENTER Giga-tronics;Nums(*)
190         GCLEAR
200         PEN 2
210         GRID 10,10
220         PEN 1
230         MOVE 1,Nums(1)
240         FOR I=1 TO N
250             DRAW I,Nums(I)
260         NEXT I
270     GOTO Mainloop
280         OUTPUT Giga-tronics;FBUF OFF
300         END
```

A.7 Fast Buffered Demo: POST TTL

```
10      ! RE-STORE FAST BUFFERED
20      !
30      ! DEMO PROGRAM FOR 8540C FAST BUFFERED MODE WITH TTL TRIGGER
40      !
50      ! 2/13/92
60      !
70      Giga-tronics=713
80      N=200
90      OPTION BASE 1
110         REAL Nums(200)
120         OUTPUT Giga-tronics;PRLG
130         OUTPUT Giga-tronics;FBUF POST TTL BUFFER;N
140         WAIT .5
145         WINDOW 1,N,-70,20
150     Mainloop
170         ENTER Giga-tronics;Nums(*)      ! waits here until TTL trigger happens
190         GCLEAR
200         PEN 2
210         GRID N/10,10
220         PEN 1
230         MOVE 1,Nums(1)
240         FOR I=1 TO N
250             DRAW I,Nums(I)
260         NEXT I
270     GOTO Mainloop
300     END
```

B

Power Sensors

B.1 Introduction

This appendix contains the selection, specifications and calibration data for the Giga-tronics power sensors used with the Series 8540C Universal Power Meters. This appendix is divided into the following sections:

- Power Sensor Selection
- Modulation Sensor Specifications
- Peak Power Sensor Selection
- Local Calibration Factors
- Remote Calibration Factors

All Giga-tronics power sensors contain balanced zero-biased Schottky diodes for power sensing.

Caution

Input power in excess of +23 dBm (200 mW, which is the 100% average for standard and pulse sensors) can degrade or destroy these diodes. Diodes degraded or destroyed in this manner will not be replaced under warranty. Destructive signal levels are higher for high power, true rms, and low VSWR sensors. When connecting power sensors to other devices, do not turn the body of the sensor in order to tighten the RF connection. This can damage the connector mating surfaces.

B.2 Power Sensor Selection

The Standard 80300 Series Sensors measure CW signals from -70 to +20 dBm; the 80400 Series Sensors measure modulated or CW signals from -67 to +20 dBm; the 80601A Series Sensors measure modulated or CW signals from -67 to +20 dBm. The 8540C Series Universal Power Meters also use Peak Power Sensors for measuring radar and digital modulation signals.

Giga-tronics True RMS sensors are recommended for applications such as measuring quadrature modulated signals, multi-tone receiver intermodulation distortion power, noise power, or the compression power of an amplifier. These sensors include a pad to attenuate the signal to the RMS region of the diode's response. This corresponds to the -70 dBm to -20 dBm linear operating region of Standard CW Sensors. The pad improves the input VSWR to ≤1.15 at 18 GHz.

High Power (1, 5, 25, and 50 Watt) and Low VSWR sensors are also available for use with the Series 8540C Power Meters. Table B-1 lists the Giga-tronics power sensors used with the Series 8540C. Refer to applicable notes on page B-3. See Figures B-1 or B-2 for modulation-induced measurement uncertainty.

B.2.1 Modulation Power Sensors

Table B-1. Power Sensor Selection Guide

Model	Freq. Range/ Power Range	Maximum Power	Power Linearity[4] (Freq >8 GHz)	VSWR	RF Conn	Dimensions		Wgt
						Length	Dia	
Modulation Sensors (-70 to +20 dBm)								
80601A[9]	10 MHz to 18 GHz -60 to +20 dBm	+23 dBm (200 mW)	-67 to -20 dBm ±0.00 dB -20 to +20 dBm ±0.05 dB/10 dB	10 MHz to 2 GHz: 1.12 2 GHz to 12.4 GHz: 1.22 12.4 GHz -18 GHz: 1.29	Type N(m) 50Ω	114.5mm (4.5 in)	32 mm (1.25 in)	0.18 kg (0.4 lb)
80401A	10 MHz to 18 GHz -67 to +20 dBm	+23 dBm (200 mW)	-67 to -20 dBm ±0.00 dB -20 to +20 dBm ±0.05 dB/10 dB	10 MHz to 2 GHz: 1.12 2 GHz to 12.4 GHz: 1.22 12.4 GHz -18 GHz: 1.29	Type N(m) 50Ω	114.5mm (4.5 in)	32 mm (1.25 in)	0.18 kg (0.4 lb)
80402A	10 MHz to 18 GHz -67 to +20 dBm	+23 dBm (200 mW)	-67 to -20 dBm ±0.00 dB -20 to +20 dBm ±0.05 dB/10 dB	10 MHz to 2 GHz: 1.12 2 GHz to 12.4 GHz: 1.22 12.4 GHz -18 GHz: 1.29	APC-7 50Ω	114.5mm (4.5 in)	32 mm (1.25 in)	0.18 kg (0.4 lb)
80410A	10 MHz to 18 GHz -64 to +26 dBm	+29 dBm (800 mW)	-61 to -14 dBm ±0.00 dB -14 to + 26 dBm ±0.05 dB/10 dB	10 MHz to 2 GHz: 1.13 2 GHz to 12 GHz: 1.16 12 GHz to 18 GHz: 1.23	Type K(m)[1] 50Ω	127 mm (5.0 in)	32 mm (1.25 in)	0.23 kg (0.5 lb)
80420A	10 MHz to 18 GHz -60 to +30 dBm	+30 dBm (1 W)	-57 to -10 dBm ±0.00 dB -10 to +30 dBm ±0.05 dB/10 dB	10 MHz to 2 GHz: 1.11 2 GHz to 12 GHz: 1.12 12 GHz to 18 GHz: 1.18	Type K(m)[1] 50Ω	127 mm (5.0 in)	32 mm (1.25 in)	0.23 kg (0.5 lb)
80421A	10 MHz to 18 GHz -50 to +37 dBm	+37 dBm (5 W)	-47 to +0 dBm ±0.00 dB 0 to +37 dBm ±0.05 dB/10 dB	10 MHz to 6 GHz: 1.20 8 GHz to 12.4 GHz: 1.25 12.4 GHz to 18 GHz: 1.35	Type N(m) 50Ω	150 mm (5.9 in)	32 mm (1.25 in)	0.23 kg (0.5 lb)
80422A	10 MHz to 18 GHz -40 to +44 dBm	+44 dBm (25 W)	-37 to +10 dBm ±0.00 dB +10 to +44 dBm ±0.05 dB/10 dB	10 MHz to 6 GHz: 1.20 6 GHz to 12.4 GHz: 1.30 12.4 GHz to 18 GHz: 1.40	Type N(m) 50Ω	230 mm (9.0 in)	104 mm (4.1 in)	0.3 kg (0.6 lb)
80425A	10 MHz to 18 GHz -40 to +47 dBm	+47 dBm (50 W)	-34 to +10 dBm ±0.00 dB +10 to +47 dBm ±0.05 dB/10 dB	10 MHz to 6 GHz: 1.25 6 GHz to 12.4 GHz: 1.35 12.4 GHz to 18 GHz: 1.45	Type N(m) 50Ω	230mm (9.0 in)	104 mm (4.1 in)	0.3 kg (0.6 lb)
Standard CW Sensors								
80301A	10 MHz to 18 GHz -70 to +20 dBm	+23 dBm (200 mW)	-70 to -20 dBm ±0.00 dB -20 to +20 dBm ±0.05 dB/10 dB	10 MHz to 2 GHz: 1.12 2 GHz to 12.4 GHz: 1.22 12.4 GHz -18 GHz: 1.29	Type N(m) 50Ω	114.5mm (4.5 in)	32 mm (1.25 in)	0.18 kg (0.4 lb)
80302A	10 MHz to 18 GHz -70 to +20 dBm	+23 dBm (200 mW)	-70 to +20 dBm ±0.00 dB -20 to +20 dBm ±0.05 dB/10 dB	10 MHz to 2 GHz: 1.12 2 GHz to 12.4 GHz: 1.22 12.4 GHz to 18 GHz: 1.29	APC-7 50Ω	114.5mm (4.5 in)	32 mm (1.25 in)	0.18 kg (0.4 lb)
80303A	10 MHz to 26.5 GHz -70 to +20.0 dBm	+23 dBm (200 mW)	-70 to +20 dBm ±0.00 dB -20 to +20 dBm ±0.1 dB/10dB	10 MHz to 2 GHz: 1.12 2 GHz to 12.4 GHz: 1.22 12.4 GHz -18 GHz: 1.38 18 GHz -26.5 GHz: 1.43	Type K(m)[1] 50Ω	114.5mm (4.5 in)	32 mm (1.25 in)	0.18 kg (0.4 lb)
80304A	10 MHz to 40 GHz -70 to 0 dBm	+23 dBm (200 mW)	-70 to -20 dBm ±0.00 dB -20 to 0 dBm ±0.2 dB/10 dB	10 MHz to 2 GHz: 1.12 2 GHz to 12.4 GHz: 1.22 12.4 GHz -18 GHz: 1.38 18 GHz -26.5 GHz: 1.43 26.5 GHz to 40 GHz: 1.92	Type K(m)[1] 50Ω	114.5mm (4.5 in)	32 mm (1.25 in)	0.23 kg (0.5 lb)
Low VSWR CW Sensors								
80310A	10 MHz to 18 GHz -64 to +26 dBm	+29 dBm (800 mW)	-64 to -14 dBm ±0.00 dB -14 to + 26 dBm ±0.05 dB/10 dB	10 MHz to 2 GHz: 1.13 2 GHz to 12 GHz: 1.16 12 GHz to 18 GHz: 1.23 18 GHz to 26.5 GHz: 1.29 26.5 GHz to 40 GHz: 1.50	Type K(m)[1] 50Ω	127mm (5.0 in)	32 mm (1.25 in)	0.23 kg (0.5lb)
80313A	10 MHz to 26.5 GHz -64 to +26 dBm		-64 to -14 dBm ±0.00 dB -14 to + 26 dBm ±0.1 dB/10 dB					
80314A	10 MHz to 40 GHz -64 to +6 dBm		-64 to -14 dBm ±0.00 dB -14 to + 6 dBm ±0.2 dB/10 dB					
1W CW Sensors								
80320A	10 MHz to 18 GHz -60 to +30 dBm	+30 dBm (1 W)	-60 to -10 dBm ±0.00 dB -10 to +30 dBm ±0.05 dB/10 dB	10 MHz to 2 GHz: 1.11 2 GHz to 12 GHz: 1.12 12 GHz to 18 GHz: 1.18 18 GHz to 26.5 GHz: 1.22 26.5 GHz to 40 GHz: 1.36	Type K(m)[1] 50Ω	127 mm (5.0 in)	32 mm (1.25 in)	0.23 kg (0.5 lb)
80323A	10 MHz to 26.5 GHz -60 to +30 dBm		-60 to -10 dBm ±0.00 dB -10 to +30 dBm ±0.1 dB/10 dB					
80324A	10 MHz to 40 GHz -60 to +10 dBm		-60 to -10 dBm ±0.00 dB -10 to +10 dBm ±0.2 dB/10 dB					

Model	Freq. Range/ Power Range	Maximum Power	Power Linearity[4] (Freq >8 GHz)	VSWR	RF Conn	Dimensions Length	Dimensions Dia	Wgt
1W CW Sensors								
80320A	10 MHz to 18 GHz -60 to +30 dBm	+30 dBm (1 W)	-60 to -10 dBm ±0.00 dB -10 to +30 dBm ±0.05 dB/10 dB	10 MHz to 2 GHz: 1.11 2 GHz to 12 GHz: 1.12 12 GHz to 18 GHz: 1.18 18 GHz to 26.5 GHz: 1.22 26.5 GHz to 40 GHz: 1.36	Type K(m)[1] 50Ω	127 mm (5.0 in)	32 mm (1.25 in)	0.23 kg (0.5 lb)
80323A	10 MHz to 26.5 GHz -60 to +30 dBm		-60 to -10 dBm ±0.00 dB -10 to +30 dBm ±0.1 dB/10 dB					
80324A	10 MHz to 40 GHz -60 to +10 dBm		-60 to -10 dBm ±0.00 dB -10 to +10 dBm ±0.2 dB/10 dB					
5W CW SENSOR[2]								
80321A	10 MHz to 18 GHz -50 to +37 dBm	+37 dBm (5 W)	-50 to +0 dBm ±0.00 dB 0 to +37 dBm ±0.05 dB/10 dB	10 MHz to 6 GHz: 1.20 8 GHz to 12.4 GHz: 1.25 12.4 GHz to 18 GHz: 1.35	Type N(m) 50Ω	150 mm (5.9 in)	32 mm (1.25 in)	0.23 kg (0.5 lb)
25W CW Sensor[3]								
80322A	10 MHz to 18 GHz -40 to +44 dBm	+44 dBm (25 W)	-40 to +10 dBm ±0.00 dB +10 to +44 dBm ±0.05 dB/10 dB	10 MHz to 6 GHz: 1.20 6 GHz to 12.4 GHz: 1.30 12.4 GHz to 18 GHz: 1.40	Type N(m) 50Ω	230 mm (9.0 in)	104 mm (4.1 in)	0.3 kg (0.6 lb)
50W CW Sensor[3]								
80325A	10 MHz to 18 GHz -40 to +47 dBm	+47 dBm (50 W)	-40 to +10 dBm ±0.00 dB +10 to +47 dBm ±0.05 dB/10 dB	10 MHz to 6 GHz: 1.25 6 GHz to 12.4 GHz: 1.35 12.4 GHz to 18 GHz: 1.45	Type N(m) 50Ω	230mm (9.0 in)	104 mm (4.1 in)	0.3 kg (0.6 lb)
True RMS Sensors (-30 to +20 dBm)								
80330A 80333A 80334A	10 MHz to 18 GHz 10 MHZ to 26.5 GHz 10 MHz to 40 GHz	+33 dBm (2 W)	-30 to +20 dBm ±0.00 dB	10 MHz to 12 GHz: 1.12 12 GHz to 18 GHz: 1.15 18 GHz -26.5 GHz: 1.18 26.5 GHz -40 GHz: 1.29	Type K(m)[1] 50Ω	152.5mm (6.0 in)	32 mm 1.25 in)	0.27kg (0.6 lb)
80340 Series Peak Power Sensors (-30 to +20 dBm)								
80340A	50 MHz to 18 GHz	+23 dBm (200 mW)	-30 to 0 dBm ±0.13 dB 0 to +20 dBm	50 MHz to 2 GHz: 1.12 2 GHz to 12.4 GHz: 1.22 12.4 GHz to 18 GHz: 1.37	Type N(m) 50Ω	146 mm (5.75 in)	37 mm (1.44 in)	0.3 kg (0.6 lb)
80343A 80344A	50 MHz to 26.5 GHz 50 MHz to 40 GHz		0 to +20 dBm ±0.13 dB ±0.01 dB/dB	18 GHz -26.5 GHz: 1.50 26.5 GHz -40 GHz: 1.92	Type K(m)[1] 50Ω			

Notes:

1. The K connector is electrically and mechanically compatible with the APC-3.5 and SMA connectors.
2. Power coefficient equals <0.01 dB/Watt(AVG.)
3. Power coefficient equals <0.015 dB/Watt(AVG.)
4. For frequencies above 8 GHz, add power linearity to system linearity.
5. Peak operating range above CW maximum range is limited to <10% duty cycle.
6. Includes uncertainty of reference standard and transfer uncertainty. Directly traceable to NIST
7. Square root of sum of the individual uncertainties squared (RSS).
8. Cal Factor numbers allow for 3% repeatability when re-connecting attenuator to sensor, and 3% for attenuator measurement uncertainty and mismatch of sensor/pad combination. Attenuator frequency response is added to the Sensor Cal Factors which are stored in the sensor's EEPROM.
9. The Model 80601 is compatible with the 8541C and 8542C, and later configurations.

Table B-2. Power Sensor Cal Factor Uncertainties

Freq. (GHz)		Sum of Uncertainties (%)[6]						Probable Uncertainties (%)[7]					
Lower	Upper	80301A 80302A 80340 80401A 80402A 80601A[9]	80303A 80304A 80343 80344	80310A 80313A 80314A	80320A 80323A 80324A	80321A[8] 80322A[8] 80325A[8]	80330A 80333A 80334A	80301A 80302A 80340 80401A 80402A 80601A[9]	80303A 80304A 80343 80344	80310A 80313A 80314A	80320A 80323A 80324A	80321A[8] 80322A[8] 80325A[8]	80330A 80333A 80334A
0.1	1	1.61	3.06	2.98	2.96	7.61	2.95	1.04	1.64	1.58	1.58	4.54	1.58
1	2	1.95	3.51	3.58	3.57	7.95	3.55	1.20	1.73	1.73	1.73	4.67	1.73
2	4	2.44	4.42	4.33	4.29	8.44	4.27	1.33	1.93	1.91	1.91	4.89	1.90
4	6	2.67	4.74	4.67	4.63	8.67	4.60	1.41	2.03	2.02	2.01	5.01	2.01
6	8	2.86	4.94	4.87	4.82	8.86	4.80	1.52	2.08	2.07	2.06	5.12	2.06
8	12.4	3.59	6.04	5.95	5.90	9.59	5.87	1.92	2.55	2.54	2.53	5.56	2.53
12.4	18	4.09	6.86	6.76	6.69	10.09	6.64	2.11	2.83	2.80	2.79	5.89	2.78
18	26.5	——	9.27	9.43	9.28	——	9.21	——	3.63	3.58	3.62	——	3.59
26.5	40	——	15.19	14.20	13.86	——	13.66	——	6.05	5.54	5.39	——	5.30

Notes:

1. The K connector is electrically and mechanically compatible with the APC-3.5 and SMA connectors.
2. Power coefficient equals <0.01 dB/Watt(AVG.)
3. Power coefficient equals <0.015 dB/Watt(AVG.)
4. For frequencies above 8 GHz, add power linearity to system linearity.
5. Peak operating range above CW maximum range is limited to <10% duty cycle.
6. Includes uncertainty of reference standard and transfer uncertainty. Directly traceable to NIST
7. Square root of sum of the individual uncertainties squared (RSS).
8. Cal Factor numbers allow for 3% repeatability when re-connecting attenuator to sensor, and 3% for attenuator measurement uncertainty and mismatch of sensor/pad combination. Attenuator frequency response is added to the Sensor Cal Factors which are stored in the sensor's EEPROM.
9. The Model 80601 is compatible with the 8541C and 8542C, and later configurations.

B.2.2 Modulation Sensor Specifications

Table B-3. 804XXA Modulation Sensor Specifications

Signal Type	Test Conditions	Typical Error[1]
CW	Power level -67 to +20 dBm	none
Single Carrier with AM	Power level -67 to +20 dBm, f_m <40 kHz Power level -67 to -20 dBm, f_m >40 kHz Power level -20 to +20 dBm, f_m >40 kHz	none none see note[2]
Two-Tone	Power level -67 to +20 dBm, max carrier separation <40 kHz Power level -67 to -20 dBm, max carrier separation >40 kHz Power level -20 to +20 dBm, max carrier separation >40 kHz	none none see note[2]
Multi-Carrier	Power level -67 to +10 dBm, max carrier separation <40 kHz, ten carriers Power level -67 to -30 dBm, max carrier separation >40 kHz, ten carriers Power level -30 to +10 dBm, max carrier separation >40 kHz, ten carriers	none none see note[2]
Pulse Modulation	MAP or PAP mode, power level -67 to +20 dBm, pulse width >200 µs MAP or PAP mode, power level -67 to -20 dBm, pulse width <200 µs BAP mode, power level -40 to +20 dBm, pulse width >200 µs BAP mode, power level -40 to -20 dBm, pulse width <200 µs	none see note[2] none see note[2,3]
Burst with modulation	MAP or PAP mode, power level -67 to +20 dBm, pulse width >200 µs, f_m <40 kHz MAP or PAP mode, power level -67 to +20 dBm, pulse width >200 µs f_m >40 kHz MAP or PAP mode, power level -67 to -20 dBm, pulse width <200 µs BAP mode, power level -40 to +20 dBm, pulse width >200 µs, f_m <40 kHz BAP mode, power level -40 to +20 dBm, pulse width >200 µs, f_m >40 kHz BAP mode, power level -40 to -20 dBm, pulse width <200 µs	none see note[2] see note[2] none see note[2,3] see note[2,3]

Notes:

1. Error is in addition to sensor linearity and zero set accuracy.
2. See Figures B-1 or B-2 for modulation-related uncertainty.
3. The BAP mode does not function at input levels below -40 dBm.
4. The power levels quoted in the table are for Model 80401A. For other modulation sensors, add the values listed below to all power levels shown in Table B-3:

   For Model 80410A, add 6 dB.
   For Model 80420A, add 10 dB.
   For Model 80421A, add 20 dB.
   For Model 80422A, add 30 dB.
   For Model 80425A, add 33 dB.

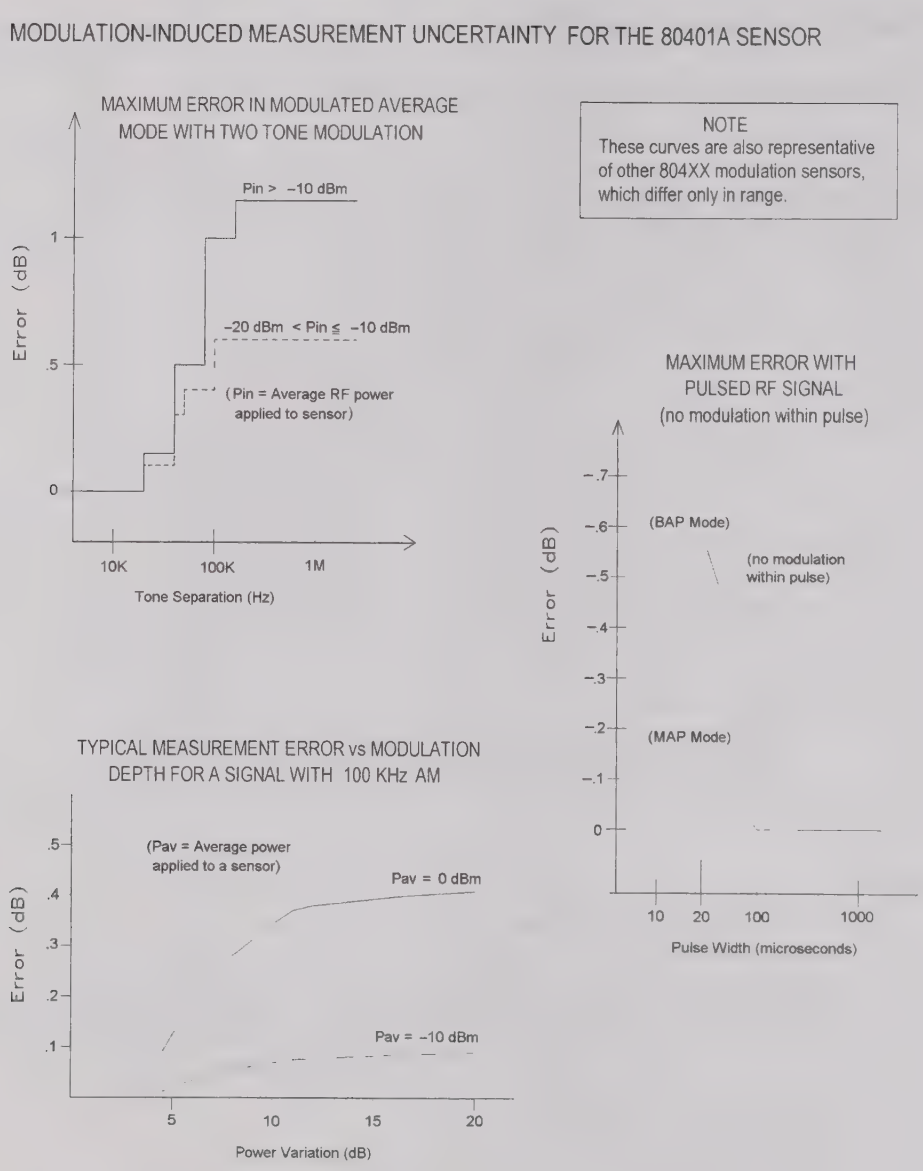


Figure B-1. 80401 Modulation-Related Uncertainty

BAP Mode Limitations:

The minimum input level is -40 dBm (average); the minimum pulse repetition frequency is 20 Hz. If the input signal does not meet these minima, the front panel **BURST AVG** LED will flash to indicate that the input is not suitable for BAP measurement. The 8540C will continue to read the input but the BAP measurement algorithms will not be able to synchronize to the modulation of the input; the input will be measured as if the 8540C were in MAP mode. In addition, some measurement inaccuracy will result if the instantaneous power within the pulse falls below -43 dBm; however, this condition will not cause the LED to flash.

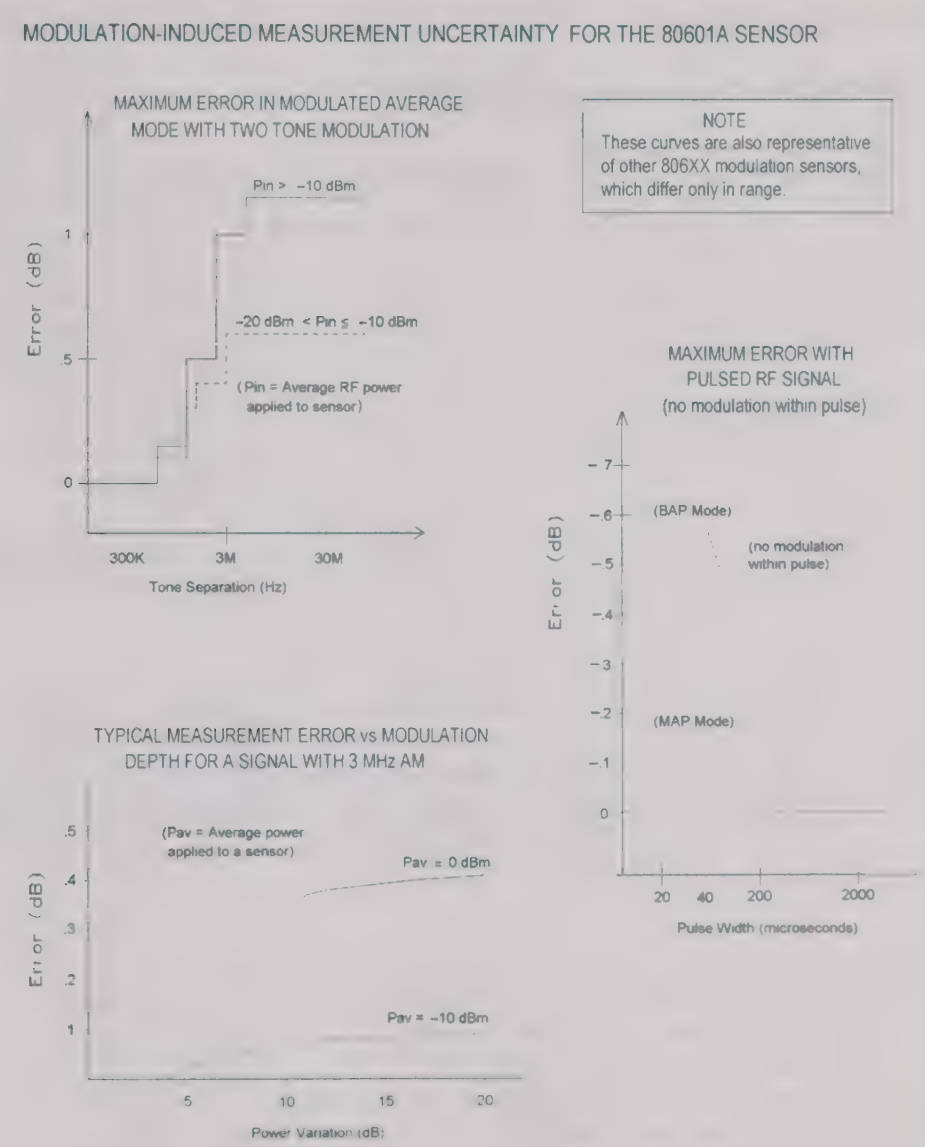


Figure B-2. 80601 Modulation-Related Uncertainty

BAP Mode Limitations:

The minimum input level is -35 dBm (average); the minimum pulse repetition frequency is 20 Hz. If the input signal does not meet these minima, the front panel **BURST AVG** LED will flash to indicate that the input is not suitable for BAP measurement. The 8540C will continue to read the input but the BAP measurement algorithms will not be able to synchronize to the modulation of the input; the input will be measured as if the 8540C were in MAP mode. In addition, some measurement inaccuracy will result if the instantaneous power within the pulse falls below -38 dBm; however, this condition will not cause the LED to flash. See Section 2.6.2 for modulation bandwidth limitations below 200 MHz. When the modulation bandwidth is below 200 MHz, the 806XX sensors' performance is equal to that of the 804XX sensors.

B.2.3 Peak Power Sensors

Table B-4. Peak Power Sensor Selection Guide

Model	Freq. Range/ Power Range	Maximum Power	Power Linearity[4]	VSWR	RF Conn	Dimensions		Wgt
						Length	Dia	
Standard Peak Power Sensors								
80350A	45 MHz to 18 GHz -20 to +20 dBm, Peak -30 to +20 dBm, CW	+23 dBm (200 mW) CW or Peak	-30 to -20 dBm ±0.00 dB -20 to +20 dBm ±0.05 dB/10 dB	45 MHz to 2 GHz: 1.12 2 GHz to 12.4 GHz: 1.22 12.4 GHz -18 GHz: 1.37	Type N(m) 50Ω	165 mm (6.5 in)	37 mm 1.25 in)	0.3 kg (0.7 lb)
80353A	45 MHz to 26.5 GHz -20 to +20 dBm, Peak -30 to +20 dBm, CW	+23 dBm (200 mW) CW or Peak	-30 to -20 dBm ±0.00 dB -20 to +20 dBm ±0.1 dB/10 dB	45 MHz to 2 GHz: 1.12 2 GHz to 12.4 GHz: 1.22 12.4 GHz to 18 GHz: 1.37 18 GHz to 26.5 GHz: 1.50	Type K(m)[1] 50Ω	165 mm (6.5 in)	37 mm (1.25 in)	0.3 kg (0.7 lb)
80354A	45 MHz to 40 GHz -20 to +0.0 dBm, Peak -30 to +0.0 dBm, CW	+23 dBm (200 mW) CW or Peak	-30 to -20 dBm ±0.00 dB -20 to 0.0 dBm ±0.2 dB/10dB	45 MHz -2 GHz: 1.12 2 GHz to 12.4 GHz: 1.22 12.4 GHz -18 GHz: 1.37 18 GHz -26.5 GHz: 1.50 26.5 GHz to 40 GHz: 1.92	Type K(m)[1] 50Ω	165 mm (6.5 in)	37 mm (1.25 in)	0.3 kg (0.7 lb)
5W Peak Power Sensor [2,5]								
80351A	45 MHz to 18 GHz 0.0 to +40 dBm, Peak -10 to +37 dBm, CW	CW: +37 dBm (5 W Avg.) Peak: +43 dBm	-10 to +0 dBm ±0.00 dB +0 to +40 dBm ±0.05 dB/10 dB	45 MHz to 4 GHz: 1.15 4 GHz to 12.4 GHz: 1.25 12.4 GHz to 18 GHz: 1.35	Type N(m) 50Ω	200 mm (7.9 in)	37 mm (1.25 in)	0.3 kg (0.7 lb)
25W Peak Power Sensor [3,5]								
80352A	45 MHz to 18 GHz +10 to +50 dBm, Peak 0.0 to +44 dBm, CW	CW: +44 dBm (25 W Avg.) Peak: +53 dBm	0.0 to +10 dBm ±dB +10 to +50 dBm ±0.05 dB/10 dB	45 MHz -6 GHz: 1.20 6 GHz to 12.4 GHz: 1.30 12.4 GHz to 18 GHz: 1.40	Type N(m) 50Ω	280 mm (11.0 in)	104 mm (4.1 in)	0.3 kg (0.7 lb)
50W Peak Power Sensor[3,5]								
80355A	45 MHz to 18 GHz +10 to +50 dBm, Peak 0.0 to +47 dBm, CW	CW: +47 dBm (50 W Avg.) Peak: +53 dBm	0.0 to +10 dBm ±0.00 dB +10 to +50 dBm ±0.05 dB/10 dB	45 MHz to 6 GHz: 1.25 6 GHz to 12.4 GHz: 1.35 12.4 GHz to 18 GHz: 1.45	Type N(m) 50Ω	280 mm (11.0 in)	104 mm (4.1 in)	0.3 kg (0.7 lb)

Notes:

1. The K connector is electrically and mechanically compatible with the APC-3.5 and SMA connectors.
2. Power coefficient equals <0.01 dB/Watt(AVG.)
3. Power coefficient equals <0.015 dB/Watt(AVG.)
4. For frequencies above 8 GHz, add power linearity to system linearity.
5. Peak operating range above CW maximum range is limited to <10% duty cycle.

Table B-5. Peak Power Sensor Cal Factor Uncertainties

Freq. (GHz)		Sum Of Uncertainties (%)[1]					Probable Uncertainties (%)[2]		
Lower	Upper	80350A	80353A 80354A	80351A[3]	80352A[3]	80355A[3]	80350A	80353A 80354A	80351A[3] 80352A[3] 80355A[3]
0.1	1	1.61	3.06	9.09	9.51	10.16	1.04	1.64	4.92
1	2	1.95	3.51	9.43	9.85	10.50	1.20	1.73	5.04
2	4	2.44	4.42	13.10	13.57	14.52	1.33	1.93	7.09
4	6	2.67	4.74	13.33	13.80	14.75	1.41	2.03	7.17
6	8	2.86	4.94	13.52	13.99	14.94	1.52	2.08	7.25
8	12.4	3.59	6.04	14.25	14.72	15.67	1.92	2.55	7.56
12.4	18	4.09	6.86	19.52	20.97	21.94	2.11	2.83	12.37
18	26.5	—	9.27	——	——	——	—	3.63	——
26.5	40	—	15.19	——	——	——	—	6.05	——

Notes:

1. Includes uncertainty of reference standard and transfer uncertainty. Directly traceable to NIST.
2. Square root of sum of the individual uncertainties squared (RSS).
3. Cal Factor numbers allow for 3% repeatability when re-connecting attenuator to sensor and 3% for attenuator measurement uncertainty and mismatch of sensor/pad combination. Attenuator frequency response is added to the Sensor Cal Factors which are stored in the sensor's EEPROM.
4. For additional specifications, see the Series 80350A manual and data sheet.

B.2.4 Directional Bridges

The 80500 Series CW Directional Bridges are designed specifically for use with Giga-tronics power meters to measure the Return Loss/SWR of a test device. Each bridge includes an EEPROM which has been programmed with Identification Data for that bridge.

Table B-6. Directional Bridge Selection Guide

Model	Freq. Range/ Power Range	Maximum Power	Power Linearity	Test Port Match (SWR)	Directivity (dB)	Input conn	Test Port conn
80501	10 MHz to 18 GHz -35 to +20 dBm	+27 dBm (0.5W)	-35 to +10 dBm ±0.1 dB +10 to +20 dBm ±0.1 dB ±0.005 dB/dB	10 MHz to 8 GHz: <1.17 8 GHz to 18 GHz: <1.27	38	N(f)	N(f)
80502	10 MHz to 18 GHz -35 to +20 dBm	+27 dBm (0.5 W)	-35 to +10 dBm ±0.1 dB +10 to +20 dBm ±0.1 dB ±0.005 dB/dB	10 MHz to 8 GHz: <1.13 8 GHz to 18 GHz: <1.22	40	N(f)	APC-7
80503	10 MHz to 26.5 GHz -35 to +20 dBm	+27 dBm (0.5 W)	-35 to +10 dBm ±0.1 dB +10 to +20 dBm ±0.1 dB ±0.005 dB/dB	10 MHz to 8 GHz: <1.22 8 GHz to 18 GHz: <1.22 18 GHz to 26.5 GHz: <1.27	35	SMA(f)	SMA(f)
80504	10 MHz to 40 GHz -35 to +20 dBm	+27 dBm (0.5 W)	-35 to +10 dBm ±0.1 dB +10 to +20 dBm ±0.1 dB ±0.005 dB/dB	10 MHz to 8 GHz: <1.35 8 GHz to 18 GHz: <1.35 18 GHz to 26.5 GHz: <1.35 26.5 GHz to 40 GHz: <1.44	30	K(f)	K(f)

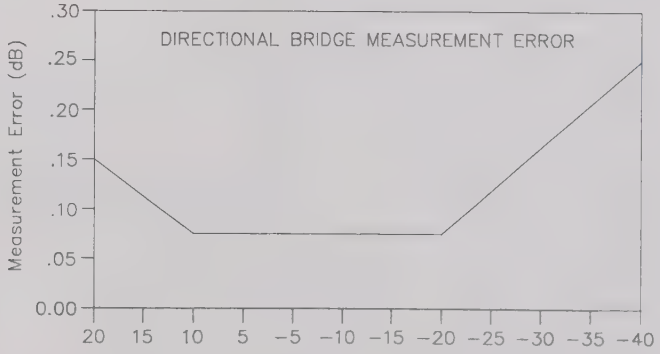
The Selection Guide in Table B-6 shows primary specifications. Additional specifications are:

Bridge Frequency Response: Return loss measurements using the 8541/2 power meter can be frequency compensated using the standard *Open/Short* supplied with the bridge.

Insertion Loss: 6.5 dB, nominal, from input port to test port

Maximum Input Power: +27 dBm (0.5 W)

Directional Bridge Linearity Plus Zero Set & Noise vs Input Power (50 MHz, 25 °C ±5 °C):



Dimensions:
80501: 76 x 50 x 28 mm (3 x 2 x 1 1/8 in)
80502: 76 x 50 x 28 mm (3 x 2 x 1 1/8 in)
80503: 19 x 38 x 29 mm (3/4 x 1 1/2 x 2 1/8 in)
80504: 19 x 38 x 29 mm (3/4 x 1 1/2 x 2 1/8 in)

Weight:
80501: 340 g (12 oz)
80502: 340 g(12 oz)
80503: 198 g (7 oz)
80504: 198 g (7 oz)

Directional Bridge Accessories: An Open/Short is included for establishing the 0 dB return loss reference during path calibration.

B.3 Power Sensor Calibration

Power sensors used with the Series 8540C Universal Power Meters have EEPROMs that manage the calibration data. You can change existing data or program special calibration data for user-specific frequencies.

The calibration process generates a correction factor expressed in dB for each frequency, and compares the measured power with a power standard. The Series 8540C uses cal factors expressed in dB but many calibration labs generate cal factors in percentage.

B.3.1 Local Calibration

Local calibration uses the front panel menu of the Series 8540C for programming power sensor EEPROMs.

Equipment Required

Series 8540C Universal Power Meter
Power Sensor

User Menus

To select a menu, press [MENU] and cursor up or down until the desired menu is showing. Press [ENTER] to move to the next menu level. To change the value in a menu, move the cursor to the digit to be changed and select its new value with the up/down cursor keys. Each digit must be individually selected and changed.

Some Series 8540C software versions will not contain all of the menus listed in this Applications Note. If any menu is missing, disregard the procedural step and proceed to the next menu.

Procedure

Connect the power sensor to Channel A or B on the Series 8540C front panel.

Press [MENU] and cursor to **SERVICE MENU**. Press [ENTER]. Cursor to **SENSOR ROM** and press [ENTER]

S_EE **Model#: 80401**	Model number of the in-use sensor. **This number should not be altered**. If the model number in the menu does not match the number printed on the sensor, contact Giga-tronics for assistance.
S_EE **SNumb: 1234567**	Serial number of the in-use sensor. **This number should not be altered**. If the serial number in the menu does not match the number printed on the sensor, contact Giga-tronics for assistance.
S_EE **CalLoc: nn**	A 2-digit user-specified number to identify the location of the last calibration (e.g., Cal Lab 01). It should be changed to the location where you are now calibrating the unit.
S_EE **CDate: 2/17/96**	Date of the last calibration. You should change it to the date of the current calibration. The format is mm/dd/yy.
S_EE **CTime: 13:55:00**	Time of the last calibration. You should change it to the time of the current calibration. The 24-hour format is hh:mm:ss
S_EE **LwFrq: f.f f f**	Lower frequency range (in GHz) of the power sensor under test. **The value should not be altered.**

S_EE HiFrq: f f.f f_f	High frequency range (in GHz) of the power sensor under test. **The value should not be altered.**
S_EE Video+: n.nnn	Video impedance of the *positive* detector in the power sensor. **It should not be altered**. If the diode is changed, enter the impedance value furnished with the new diode.
S_EE Video-: n.nnn	Video impedance of the *negative* detector in the power sensor. **It should not be altered** unless you have changed the detector diode. If the diode is changed, enter the impedance value furnished with the new diode.
S_EE FStart: 2.000	The first frequency (in GHz) in the list of equally spaced frequencies at which the sensor was last calibrated. These frequencies can be changed to meet user-specific applications, but it is recommended that you leave these unaltered and instead set up user-specific calibration frequencies from the **FSPLITEMS** menu. The factory default is 2.000.
S_EE FStep: 1.000	This frequency (in GHz) is the step size or spacing of frequencies at which the sensor was last calibrated. If you alter the spacing, you will also alter the factory calibration frequencies. If you alter the step value without changing either FStart or FItems (or both), the value will not be accepted. The factory default is 1.000.
S_EE FItems: nn	This is the number of equally-spaced steps from **FSTART** to **HIFRQ**. You will need to calculate this value based on the FStart frequency and the frequency range of the sensor. If you alter this number, you may also need to alter the frequency in **FSTART**. If you alter the number of steps without altering the start frequency, you may cut off the upper frequencies and prevent calibration. Values in excess of the allowable range will not be accepted. For example, if the start frequency is 2 GHz, the sensor maximum range is 20 GHz, and you select 2 GHz steps, the maximum number of allowable steps is 10. If you enter 20 steps in this example, the value will not be accepted. Thus, the allowable number of steps is the maximum frequency less the start frequency divided by the step value plus 1 (because the first step is the start frequency).
S_EE FSpIItems: n	The number of user-specified calibration frequencies to be set up. Change the number as desired. The factory default is 1. Refer to **SFRQ** for setting up the frequencies. The 26.56 GHz sensors have two special frequencies.

RLStart	Reserved for factory use
RLStep	Reserved for factory use
RLItems	Reserved for factory use
RLSpIItems	Reserved for factory use
S_EE ACoef thru **HCoef**	These are coefficients which describe the sensor's behavior above 8 GHz. If the sensor response after calibration deviates greater than ± 0.02 dBm, contact the factory for assistance. **These values should be changed only when a new diode module is installed.**
S_EE Frq: (1) f.fff (-*n.nn*)	First (1) in the list of calibration frequencies followed by the frequency (*f.fff*) in GHz and the correction factor (-*n.nn*) in dB. A first calibration frequency of 2 GHz is the factory default. Each step number, shown in parenthesis on the first line, will increase the frequency by the value in the **FSTEP** menu. **The correction factor (-*nn.n*) should not be altered unless new calibration data has been taken.**
S_EE SFrq: (1) f.fff (-n.nn)	First (1) in the list of special (user-specified) calibration frequencies followed by the frequency (f.fff) in GHz and the correction factor (-*n.nn*) in dB. The first special calibration frequency of 0.5 MHz is a factory default. The number of steps (shown in parenthesis on the first line) will depend on the sensor's frequency range and the value in the **FSTEP** menu. Each progressive step will increase the frequency by the number in the **FSPLITEMS** menu. **The correction factor (-*n.nn*) should not be altered unless new calibration data has been taken.**
Program EEPROM? Exit or Write	Move the cursor to select either **Exit** to leave the calibration function without saving changes, or **Write** to write the changes to EEPROMs. The **Write** selection will open the Password menu.

B.3.2 Remote Calibration

Power sensors used with the Series 8540C Universal Power Meters have built-in EEPROM data that manage the cal factors by a set of frequencies entered during calibration of the sensor at the factory. You can program additional cal factors with special data for user-specific frequencies.

A cal factor expressed in dB is programmed for each factory-calibrated frequency. The calibration process compares the measurement to the frequency standard and applies the cal factor to offset frequency deviations.

Some 8540C software versions will not contain all of the menus listed here. If any menu is missing, disregard the procedural step and proceed to the next menu.

This procedure is for calibrating a power sensor by remote control with a Series 8540C Universal Power Meter via the IEEE-488 interface bus. This procedure writes the cal factors to the sensor EEPROM.

Equipment Required

Series 8540C Universal Power Meter
Power Sensor

Procedure

Connect the power sensor to Channel A or B on the Series 8540C front panel, and perform the following steps. In this procedure, bold letters are commands; the query form of a command has a question mark (?) at the end of the command. This form returns the data in the EEPROM.

1. **TEST EEPROM A (or B) READ**

   Read sensor A (or B) EEPROM data into the 8540C editor buffer.

2. (Optional) **TEST EEPROM A (or B) CALFR?**

   a. Query sensor A (or B) standard cal factor start frequency, number of standard frequencies, and number of special frequencies.

   b. Read the standard cal from the input buffer and extract the start frequency and number of standard frequencies.

   c. Calculate and set the frequencies of the cal factor table.

3. **TEST EEPROM A (or B) CALFST?**

   a. Query sensor A (or B) standard cal factor table.

   b. Read the standard cal from the input buffer and extract the standard cal factor; e.g., INPUT (GPIB address).

   c. Set the sensor standard cal factor table.

   d. Make changes from the table and put them back into the table.

   e. After all changes are made, put the table back into the input buffer.

4. **TEST EEPROM A (or B) WRITE**

   a. Write sensor A (or B) EEPROM data into the 8540C buffer.

   b. Restore the input buffer from step 3.e to the EEPROM buffer (e.g., OUTPUT [GPIB] address, input buffer).

   c. Write sensor A (or B) editor buffer data into the EEPROM with the password number; e.g., OUTPUT (GPIB address, TEST EEPROM A [or B] WRITE 0)

   d. Editing the EEPROM routine is complete.

C

Options

C.1 Introduction

The following options are available for Series 8540C, and are discussed under separate headings:

Option 01:	Rack Mount Kit	21334
Option 02:	Add 250K Buffer	21335
Option 03:	8541C Rear Panel Connections	29864
Option 04:	8542C Rear Panel Connections	29865
Option 05:	Soft Carry Case	21312
Option 06:	8542C Second Analog Output	29868
Option 07:	Side-mounted Carrying Case	21339
Option 08:	Transit Case (Includes Soft Carry Case)	21339
Option 09:	Dual Power Meter Rack Mount Kit	21684
Option 10:	Assembled Dual Power Meter Rack Mount	21647
Option 11:	Time Gating Measurement	29863

Parts lists are included with the applicable option in this appendix. Drawings for Option 06 and Option 11 are in Chapter 8.

C.2 Option 01: Rack Mount Kit

Option 01 is a rack mounting kit for the 8540C.

Parts List for: 21334 RACK MOUNT KIT, 8540/01, Rev: A

Item	Part Number	Qty	Cage	Mfr's Part Number	Description
1	21395	1	58900	21395	RACK EAR, 3.5, SIDE
2	21396	1	58900	21396	RACK EAR, 3.5, PANEL
3	21399	1	58900	21399	INSTRUCTION SHEET,8540/01
10701-001	2	58900	10701-001	ROUND NICKEL HANDLE	
5 10702	4	58900	10702	HANDLE FERRULE	
HBFP-63206	4	58900	HBFP-63206		6-32 X 3/8 FLAT
HBFP-63208	4	26233	NS139CR632R8		6-32 X 1/2 FLAT

C.3 Option 02: 256K Buffer

This option adds a 256K buffer to the 8540C memory, which can be used to store data in the fast measurement collection modes (up to 128,000 readings can be stored).

Parts List for: 21335 EXTRA MEMORY,128K, 8540/02, Rev: A

Item	Part Number	Qty	Cage	Mfr's Part Number	Description
1	21594	1	58900	21594	INST SHT,8540 OPT 02
U 29	21165	1	61802	TC551001BPL-85	TC551001BPL-10 1M RAM
U 30	21165	1	61802	TC551001BPL-85	TC551001BPL-10 1M RAM

C.4 Option 03: Rear Panel Connections, Model 8541C

When Option 03 is installed, the Calibrator and Sensor connectors (which are normally placed on the front panel of the 8541C) are relocated to the rear panel.

Parts List for: 29864 8541C/03 REAR PANEL CONN, Rev: C

Item	Part Number	Qty	Cage	Mfr's Part Number	Description
1	21199-001	1	58900	21199-001	CABLE ASSY, SENSOR INPUT
2	30615	1	58900	30615	REAR OUTPUT COVER
3	30241	1	58900	30241	FRONT DEC.PANEL 8541C/03
4	21347	1	58900	21347	SHIELDING LABEL
5	30614	-1	58900	30614	STANDARD COVER
6	30157	-1	58900	30157	FRONT DEC. PANEL 8541C FAB
7	21199	-1	58900	21199	CABLE ASSY, SENSOR INPUT

C.5 Option 04: Rear Panel Connections, Model 8542C

If Option 04 is installed, the Calibrator and Sensor connectors (which are normally placed on the front panel of the 8542C) are relocated to the rear panel.

Parts List for: 29865 8542C/04 REAR PANEL CONN, Rev: C

Item	Part Number	Qty	Cage	Mfr's Part Number	Description
1	21199-001	2	58900	21199-001	CABLE ASSY, SENSOR INPUT
2	30615	1	58900	30615	REAR OUTPUT COVER
3	30243	1	58900	30243	FRONT DEC.PANEL 8542C/04
5	30614	-1	58900	30614	STANDARD COVER
6	30170	-1	58900	30170	FRONT DEC. PANEL 8542C FAB.
7	21199		58900	21199	CABLE ASSY, SENSOR INPUT

C.6 Option 05: Soft Carrying Case

Option 05 is a padded, soft carrying case for the 8540C. The part number of the case is 21312.

C.7 Option 06: Second Analog Output

C.7.1 Introduction

Option 06 provides a second analog output for the dual channel Model 8542C. It has more flexibility than the standard analog output in that it can be configured to operate from 0 to +10 V or -10 to +10 V. Chapter 3 includes a description of the remote control commands applicable to this option (see *ANALOG*). To set the option 06 function from the front panel, proceed as follows:

Press [MENU].
Scroll down to SETUP MENU.
Scroll down to ANALOG OUTPUT.
Scroll down to STD OUTPUT MODE
Select OFF.
Press [ENTER].

The Option 06 PC board plugs into the CPU PC board in the 8542C using the A1J8 development board connector and the A1J11 power connector called MUXR Power. The output of the board is a separate wire which connects from J3 on the option 06 board to the Spare I/O BNC (J5) on the rear panel of the 8542C. This connection is made by removing resistor A1R13 from the CPU board and connecting the wire from the option 06 board to the BNC end of the removed resistor.

C.7.2 Theory of Operation

The circuit description given below refers to the Option 06 Circuit Schematic (drawing #21388 in Chapter 8).

The circuit consists of a DAC, U1, an output amplifier, U2A, line buffers, U4A/B, and 4 sets of configuration jumpers, W1 to W4. The 8542C CPU is able to read the configuration of the option 06 function by making the CSRS232 line true and reading the lower data byte which will be the W4 jumper condition. This can be seen in the lower left corner of the SD. To set the DAC output, the CPU will make the CSRS232 line true and then write 12 bits of the 16 bit word. The output of the DAC is applied to the non-inverting operational amplifier, U2A, through an R/C filter with a 1 ms time constant. The gain of the amplifier is either 1 or 2 depending on the setting of jumper W1. The output of U2A is isolated by a current limiting resistor, A1R4, and connected to the J5 Spare I/O BNC on the rear panel via J3 on the option 06 PC board. The actual output voltage range is selected by setting jumpers at W1 to W4 as shown in Table C-1.

Table C-1. Output Voltages

OUTPUT	W1	W2	W3	W4
0 to +10 V	B	B	B	B
-10 to +10 V	A	A	A	A

CAUTION

Never connect W2B and W3A together; this will short the reference voltage to ground.

All jumpers other than those noted above remain in place. The -10 to +10 V output range setting is the factory-set default. Note that the DAC OFFSET input can be connected either to the reference voltage output or to ground. The former will provide -5 to +5 V output to the amplifier, and the latter will provide 0 to +10 V output. To get -10 to +10 V, the amplifier is connected for a gain of 2 (W1A).

Parts List for: 29868 Option 06 Second Analog Output, 8542C, Rev: A

Item		Part Number	Qty	Cage	Mfr's Part Number	Description
	1	21387	1	58900	21387	MODEL 8540 OPT 06 PCB ASSY
	2	30535	REF	58900	30535	8542C OPT 06 SYSTEM SCH
	3	21463	1	58900	21463	LABEL,ANALOG OUT 2
	4	21504-001	1	55566	30157	SELF-STICK SUPPORT POST
	5	10415	1	58900	10415	LABEL, OPTION IDENTIFICATION
	6	14514-001	1	58900	14514-001	CONTACT POST
W	1	21390	1	58900	21390	CABLE ASSY MODEL 8540 OPT 06

Parts List for: 21387 Model 8542C Option 06 PCB Assy, Rev: B

Item		Part Number	Qty	Cage	Mfr's Part Number	Description
	1	21386	1	58900	21386	PC BOARD MODEL 8540 OPTION 06
	2	14514-001	21	58900	14514-001	CONTACT POST
C	1	15776-005	1	51642	150-50-X7R-104K	.1 UF CERAMIC X7R
C	2	15776-005	1	51642	150-50-X7R-104K	.1 UF CERAMIC X7R
C	3	CE50-R6100	1	55680	UVX1H100MDA	10 UF 50V RADIAL LEAD
C	4	CC50-03100	1	31433	C315C103K5R5CA C9248	.01 UF CERAMIC X7R
C	5	CC50-03100	1	31433	C315C103K5R5CA C9248	.01 UF CERAMIC X7R
C	6	CC50-03100	1	31433	C315C103K5R5CA C9248	.01 UF CERAMIC X7R
C	7	CC50-03100	1	31433	C315C103K5R5CA C9248	.01 UF CERAMIC X7R
C	8	CC50-03100	1	31433	C315C103K5R5CA C9248	.01 UF CERAMIC X7R
C	9	CC50-03100	1	31433	C315C103K5R5CA C9248	.01 UF CERAMIC X7R
C	10	CE50-R6100	1	55680	UVX1H100MDA	10 UF 50V RADIAL LEAD
C	11	CE50-R6100	1	55680	UVX1H100MDA	10 UF 50V RADIAL LEAD
C	12	CC50-03100	1	31433	C315C103K5R5CA C9248	.01 UF CERAMIC X7R
C	13	CE50-R6100	1	55680	UVX1H100MDA	10 UF 50V RADIAL LEAD
C	14	CC50-03100	1	31433	C315C103K5R5CA C9248	.01 UF CERAMIC X7R
C	15	CC50-03100	1	31433	C315C103K5R5CA C9248	.01 UF CERAMIC X7R
C	16	CC50-03100	1	31433	C315C103K5R5CA C9248	.01 UF CERAMIC X7R
C	17	CC50-03100	1	31433	C315C103K5R5CA C9248	.01 UF CERAMIC X7R
C	18	CE50-R6100	1	55680	UVX1H100MDA	10 UF 50V RADIAL LEAD
J	1	21168	1	55322	SSW-125-01-T-D	50 PIN STRIPLINE SOCKET
J	2	19477-003	1	2M631	640456-4	CONN HDR POST STR LOCK 4POS
J	3	14514-001	1	58900	14514-001	CONTACT POST
R	1	RN55-21000	1	19701	RN55C1002F	10 K OHMS 1% MET FILM
R	2	RN55-21000	1	19701	RN55C1002F	10 K OHMS 1% MET FILM
R	3	RN55-21000	1	19701	RN55C1002F	10 K OHMS 1% MET FILM
R	4	RN55-03920	1	91637	RN55C3920F	392 OHMS 1% MET FILM
R	5	RN55-00100	1	19701	RN55D10R0F	10 OHMS 1% MET FILM
RP	1	14882-001	1	01121	110A103	10K OHM X 9 SIP NETWORK
U	1	21187	1	24335	AD7245JN	AD7245JN 12 BIT D/A
U	2	17714	1	01245	LM358AP	LM358AN DUAL OP AMP
U	3	UTN0-00002	1	27014	MC74HC00N	74HC00 QUAD 2IN NAND GATE
U	4	17048-015	1	3W023	74HCT244N	74HCT244N OCTAL BUFFER
W	1	14514-001	1	58900	14514-001	CONTACT POST
W	2	14514-001	1	58900	14514-001	CONTACT POST
W	3	14514-001	1	58900	14514-001	CONTACT POST
W	4	14514-001	1	58900	14514-001	CONTACT POST
WA	4	17240-001	1	27264	15-38-1024	JUMPER,INSULATED,2 POS
WB	1	17240-001	1	27264	15-38-1024	JUMPER,INSULATED,2 POS
WB	2	17240-001	1	27264	15-38-1024	JUMPER,INSULATED,2 POS
WB	3	17240-001	1	27264	15-38-1024	JUMPER,INSULATED,2 POS
WC	4	17240-001	1	27264	15-38-1024	JUMPER,INSULATED,2 POS
WD	4	17240-001	1	27264	15-38-1024	JUMPER,INSULATED,2 POS
WE	4	17240-001	1	27264	15-38-1024	JUMPER,INSULATED,2 POS
WF	4	17240-001	1	27264	15-38-1024	JUMPER,INSULATED,2 POS
WG	4	17240-001	1	27264	15-38-1024	JUMPER,INSULATED,2 POS
WH	4	17240-001	1	27264	15-38-1024	JUMPER,INSULATED,2 POS

C.8 Option 07: Side-mounted Carry Case

Option 07 is a side-mounted carrying case for the 8540C.

Parts List for: 21339 Side-Mounted Carry Handle 8540/07, Rev: A

Item	Part Number	Qty	Cage	Mfr's Part Number	Description
1	21500	1	58900	21500	HANDLE
2	21499	2	58900	21499	RETAINER
3	HBPP-63203	2	26233	NS137CR632R3	6-32 X 3/16 PAN

C.9 Option 08: Transit Case

Option 08 is a transit case for the 8540C; this option also includes the soft case described under Option 05.

Parts List for: 21344 Transit Case/Soft Case 8540/08, Rev: 1

Item	Part Number	Qty	Cage	Mfr's Part Number	Description
1	21312	1	58900	21312	SOFT CARRYING CASE 8540/05
2	21345	1	58900	21345	TRANSIT CASE,8540 SERIES

C.10 Option 09: Dual Power Meter Rack Mount Kit

Option 09 is a field-installable dual power meter rack mounting kit (with assembly instructions) for the 8540C. The dual rack mount makes it possible to install two 8540Cs side-by-side in an instrument rack.

Parts List for: 21684 8540/09 Rack Mount Kit, Rev: A

Item	Part Number	Qty	Cage	Mfr's Part Number	Description
1	10701-001	2	58900	10701-001	ROUND NICKEL HANDLE
2	10702	4	58900	10702	HANDLE FERRULE
3	21646	REF	58900	21646	OUTLINE DWG, 8540/01A
4	21648	1	58900	21648	BRKT,LT
5	21649	1	58900	21649	BRKT,RT
6	21650	1	58900	21650	FRONT TIE,TOP
7	21651	1	58900	21651	FRONT TIE,BOTTOM
8	21652	1	58900	21652	BRKT,REAR TIE
9	HBFP-63206	4	58900	HBFP-63206	6-32 X 3/8 FLAT
10	HBFP-63212	4	26233	NS139CR632R12	6-32 X 3/4 FLAT
11	HBPP-63216	2	58900	HBPP-63216	6-32 X 1 PAN
12	HBPP-63207	4	26233	NS137CR632R7	6-32 X 7/16 PAN
13	HBFP-63210	4	26233	NS139CR632R10	6-32 X 5/8 FLAT
14	HWSS-60400	6	58900	HWSS-60400	#6 X 1/4 SPLIT LOCK
15	21653	1	58900	21653	INSTALLATION SHEET,8540/09

C.11 Option 10: Assembled Dual Power Meter Rack Mount

Option 10 is a factory-assembled dual power meter rack mount for the 8540C. The dual rack mount makes it possible to install two 8540Cs side-by-side in an instrument rack.

Parts List for: 21647 8540/10, Rack Mount, Side By Side, Rev: A

Item	Part Number	Qty	Cage	Mfr's Part Number	Description
1	10701-001	2	58900	10701-001	ROUND NICKEL HANDLE
2	10702	4	58900	10702	HANDLE FERRULE
3	21646	REF	58900	21646	OUTLINE DWG, 8540/01A
4	21648	1	58900	21648	BRKT,LT
5	21649	1	58900	21649	BRKT,RT
6	21650	1	58900	21650	FRONT TIE,TOP
7	21651	1	58900	21651	FRONT TIE,BOTTOM
8	21652	1	58900	21652	BRKT,REAR TIE
9	HBFP-63206	4	58900	HBFP-63206	6-32 X 3/8 FLAT
10	HBFP-63212	4	26233	NS139CR632R12	6-32 X 3/4 FLAT
11	HBPP-63216	2	58900	HBPP-63216	6-32 X 1 PAN
12	HBPP-63207	4	26233	NS137CR632R7	6-32 X 7/16 PAN
13	HBFP-63210	4	26233	NS139CR632R10	6-32 X 5/8 FLAT
14	HWSS-60400	6	58900	HWSS-60400	#6 X 1/4 SPLIT LOCK

C.12 Option 11: Time Gating Measurement

C.12.1 Description

The time gating measurement option limits a power measurement to a defined interval that is controlled by a start time and a duration. The start time begins after a programmable delay following a hardware trigger applied to the Trigger Input connector on the instrument's rear panel.

The option requires installation of a circuit board which plugs onto the J8 connector on the CPU PC board. The CPU senses the presence of this board and modifies its setup menus accordingly. A new sub-menu (Time Gating Mode) appears under the Measurement Setup/Advanced menus. The Time Gating Mode menu permits the following parameters to be set:

Off/Gated/Trigger — This selects between two modes of specifying the measurement period.
Off cancels the time gating function.
Gated selects the External Gating Mode in which measurements are taken while the trigger input signal is true.
Trigger selects the External Trigger Mode and initiates a sequence of timers for defining the measurement duration.

External Gating Mode

Gate Polarity — This specifies the external signal TTL high or low level as true for defining the gated time.

External Trigger Mode

Trigger Polarity — This specifies the rising or falling edge of the trigger signal as the time reference point.

Trigger Delay — This is the delay time from receipt of an externally gated trigger edge input to the start of the gated measurement period.

Gate Time — This specifies of the length of the gated measurement period.

Holdoff Time — This is the timeout period between the end of the measurement period and the time another trigger will be accepted.

C.12.2 Specifications

Trigger Delay:	0 to 327.625 ms
Gate Time:	5 µs to 327.625 ms
Holdoff Time:	0 to 327.625 ms
Delay & Range Accuracy:	±1.5 µs or 100 ppm of the set time, whichever is greater
Settability:	5 µs steps or selective by cursoring to specific digits
Rear Panel Trigger Signal Levels:	Standard TTL levels
Remote Operation:	See *GPIB Setup* in Section C.12.6.

C.12.3 Time Gating Menu

The Diagram in Figure C-1 illustrates the operation of the Time Gating Menu. The Time Gating Menu is reached from the Measurement Setup and Advanced menus. From these menus, press the up or down arrow key to move to the next desired menu. From the Time Gating Menu, press [ENTER] to display the Time Gating Mode menu. The three choices available from the Time Gating Mode menu are:

- Off to quit and cancel the time gating function
- GATE to select the External Gating Mode
- TRIG to select the External Trigger Mode

Move the cursor with the left-right cursor keys to underline the first digit of the desired choice and press [ENTER] to select it.

Some of the menus will be unavailable if the Time Gating option is not installed, or if no sensors capable of time gating are attached. For example, the Gated Sensor menus in Figure C-1 will be available only if sensors are connected to both channels.

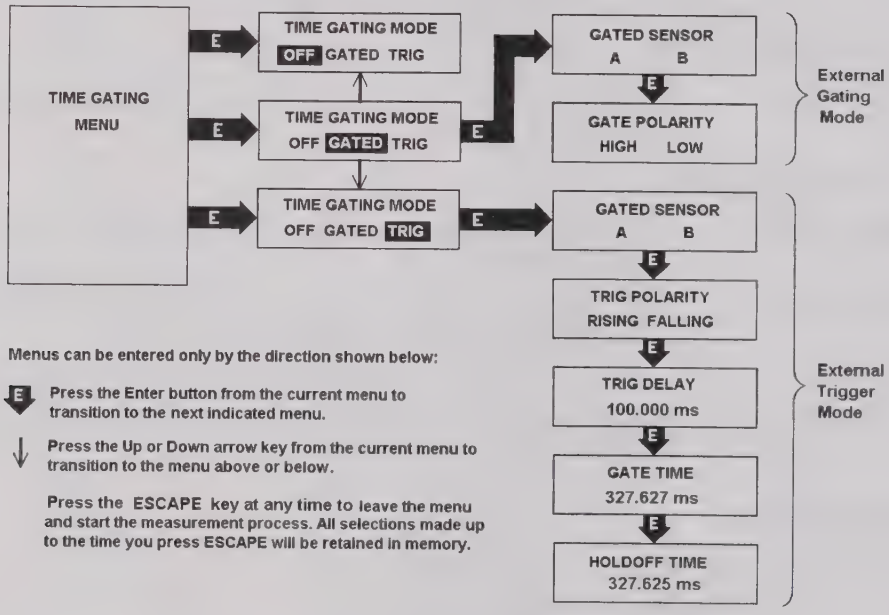

TIME GATING MENU
E
TIME GATING MODE
OFF GATED TRIG
TIME GATING MODE
OFF GATED TRIG
TIME GATING MODE
OFF GATED TRIG
GATED SENSOR
A B
GATE POLARITY
HIGH LOW
External Gating Mode
GATED SENSOR
A B
TRIG POLARITY
RISING FALLING
TRIG DELAY
100.000 ms
GATE TIME
327.627 ms
HOLDOFF TIME
327.625 ms
External Trigger Mode
Menus can be entered only by the direction shown below:
Press the Enter button from the current menu to transition to the next indicated menu.
Press the Up or Down arrow key from the current menu to transition to the menu above or below.
Press the ESCAPE key at any time to leave the menu and start the measurement process. All selections made up to the time you press ESCAPE will be retained in memory.

Figure C-1. Time Gating Option Menu Structure

C.12.4 Time Gating Mode

In this menu, you can use the right and left keys to select between OFF, GATED, and TRIG. If you select OFF (underlined, and you press ENTER), the time gating function will be cancelled and the menu exited. If you select GATED, you will enter the External Gating Mode. If you select TRIG, you will enter the External Trigger Mode.

External Gating Mode

Gated Sensor: This screen will display only if more than one sensor is connected. Otherwise, the GATE POLARITY screen will display. In this screen, you can choose the sensor input to which the time gating function is applied. Only attached sensors capable of time gating can be selected. The right and left arrow keys move between A and B. Select A or B and press [ENTER]. The GATE POLARITY screen will display.

Gate Polarity: This screen allows you to select whether measurements are made when the trigger input is high (positive level) or low (negative level). Use the left or right arrow keys to move between the selections. Press [ENTER] to select the polarity and exit the menu system.

Figure C-2 illustrates the time gated measurement with an external time gated pulse applied to the trigger input. In this mode, the time gate starts and ends with the input of a high or low TTL level input. The duration of the measurement corresponds to the duration of the gated pulse.

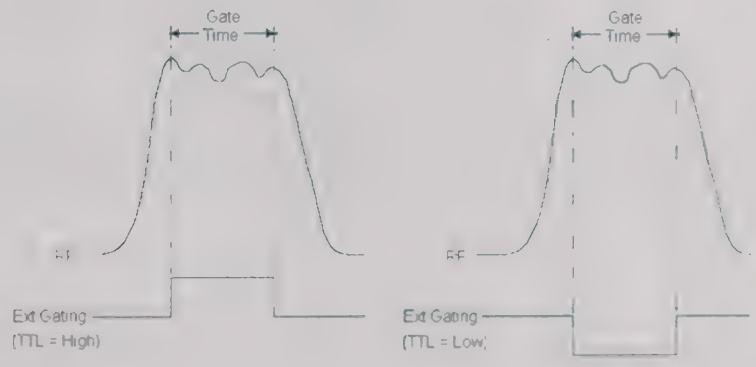


Figure C-2. External gated time measurement

External Trigger Mode

Gated Sensor: This screen will display only if more than one sensor is connected. Otherwise, the TRIG POLARITY screen will display. In this screen, you can choose the sensor input to which the time gating function is applied. Only attached sensors capable of time gating can be selected. The right and left arrow keys move between A and B. Select A or B and press [ENTER]. The TRIG POLARITY screen will display.

Trig Polarity: Use this screen to select whether the gating is triggered with a RISING or FALLING edge on the trigger input. Move between the selections with the right or left arrow keys. Press [ENTER] to select the polarity and move to the TRIG DELAY screen.

Trig Delay: From this screen you can select the delay time between the input trigger edge and the start of the gate time. The range is from 0 to 327.675 ms.

You can change the value with the up or down arrow keys in 5 µs steps each time you press the key. Alternatively, you can move the cursor to any numerical digit and then press the up or down cursor key to sequentially change the selected digit. Press [ENTER] to select the displayed value and to move to the GATE TIME screen.

Gate Time: From this screen you can select the gate time in the same manner as TRIG DELAY described above. The range is from 5 ms to 327.675 ms in 5 ms steps. Press [ENTER] to select the displayed gate time and move to the HOLDOFF TIME screen.

Holdoff Time: Use this screen to select the timeout period from the end of the gate time to the time another input trigger will be recognized and start a new measurement period. Select the holdoff time in the same manner as the TRIG DELAY described above. The range is from 0 µs to 327.675 ms in 5 µs steps. Press [ENTER] to select the displayed value and exit the menu system.

Figure C-3 illustrates the Time Gated measurement parameters with an external trigger. When an external trigger is input (point A below), it starts the Trigger Delay. At the end of the Trigger Delay, the Gated Time measurement starts and lasts until its preselected time expires. The Holdoff Time then prevents any further trigger inputs (such as point B below) from starting a new gated measurement until it has timed out.

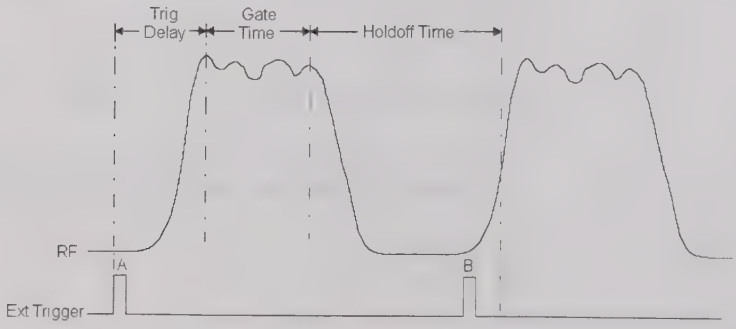


Figure C-3. External trigger gated time measurement

C.12.5 Measurement Display

When a measurement is being performed with the Time Gating Option enabled, it is indicated on the screen with a T. For example, if time gated measurements are being performed on Channel A and regular CW measurements are being performed on Channel B, the screen would appear as follows:

A T	-3.75	dBm
B	10.30	dBm

The next section describes the GPIB syntax required to set up the Time Gating Option.

C.12.6 GPIB Setup

This section describes the GPIB syntax required to set up the Time Gating Option. Figure C-4 illustrates the syntax.

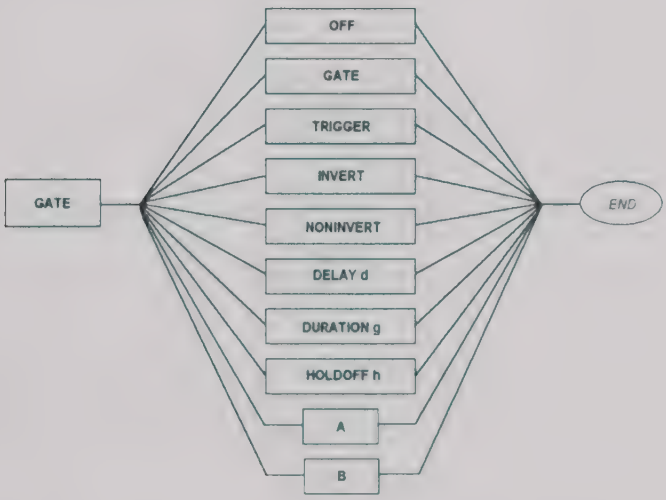


Figure C-4. GPIB Syntax for Time Gating Measurement

Gate A or B

All time gating commands begin with GATE. Only one setup data structure is stored by the meter, so the parameters specified apply to the one channel that has time gating enabled. For example, the command GATEA enables the time gating on channel A with previously specified parameters, and GATEB switches time gating to channel B with the same parameters.

OFF or GATE or TRIGGER

OFF turns off the time gating on either channel regardless of the channel specified. If GATE is sent, the time gating board is set up in the External Gating Mode. If TRIGGER is sent, the External Trigger Mode will be enabled. Although it is legal to send any of the indicated parameters in one command, only the last specified parameter is relevant. For example, if the command GATEA OFF TRIGGER GATE is sent, the time gating option will be set up in the External Gating Mode.

INVERT or NONINVERT

INVERT and NONINVERT specify the polarity of the trigger input signal. In the External Gating Mode, INVERT specifies that measurements can be taken when the trigger input is low, and NONINVERT specifies the measurements can be taken when the trigger input is high. In the External Trigger Mode, INVERT specifies that a falling edge on the trigger input triggers the gating, and NONINVERT specifies that a rising edge triggers the gating. Although it is legal to send both of the parameters in one command, only the last specified parameter is relevant.

DELAY d

DELAY *d* specifies the delay time from the trigger input edge to the start of the gating period. The *d* must be time specified in seconds in the range of 0 to 327.675 µs in 5 µs steps, where 0 represents some minimum non-zero delay time. This parameter is relevant only in the External Trigger Mode. For example, if the command

```
GATEA TRIGGER DELAY 20E-3 DURATION 250E-3 HOLDOFF 0
```

is sent, the External Trigger Mode will be enabled on channel A with a trigger delay of 20 ms. Since the previous set up may be unknown, the DELAY, DURATION, and HOLDOFF should be sent in the same command.

DURATION g

DURATION *g* specifies the duration of the gating period. The *g* must be a time specified in seconds in the range of 5 µs to 327.675 µs, with a resolution of 5 µs. This parameter is relevant only in the External Trigger Mode. For example, if the command

```
GATEA TRIGGER DELAY 20E-3 DURATION 250E-3 HOLDOFF 0
```

is sent, the External Trigger Mode will be enabled on channel A with a gate duration of 250 ms.

HOLDOFF h

HOLDOFF *h* specifies the holdoff time from the end of the gating period to the time when the circuit will accept another trigger input edge. The *h* must be a time specified in seconds in the range of 0 to 327.675 µs, with a resolution of 5 µs. This parameter is relevant only in the External Trigger Mode. For example, if the command

```
GATEA TRIGGER DELAY 20E-3 DURATION 30E-3 HOLDOFF 0
```

is sent, the External Trigger Mode will be enabled on channel A with no holdoff delay.

Error Codes

If you specify a channel where no sensor is connected, or it is a peak sensor not in CW mode, then the Entry Error bit of the Status byte is set, as well as the Execution Error bit of the Event Status register. If you request the Status Message, the code in the Entry Error portion of the message will be 64.

If you specify an out of range value for the delay, gate duration, or holdoff values, the Entry Error bit of the Status byte is also set as well as the Execution Error bit of the Event Status register. If you request the Status Message, the code in the Entry Error portion will be 65 for a delay range, 66 for a gate duration range error, and 67 for a holdoff range error.

Parts List for: 29863 Time Gating Option 11, Rev: A

Item	Part Number	Qty	Cage	Mfr's Part Number	Description
1	10415	1	58900	10415	LABEL, OPTION IDENTIFICATION
2	30442	1	58900	30442	854XC OPT 11 PC ASSY
3	30485	REF	58900	30485	8542XC OPT 11 SYSTEM SCH
4	21504-001	1	55566	30157	SELF-STICK SUPPORT POST

Parts List for: 30442 854XC OPT 11 PC ASSY, Rev: B

Item		Part Number	Qty	Cage	Mfr's Part Number	Description
	1	30441	1	58900	30441	854XC OPT 11 PCB
	2	30443	REF	58900	30443	854XC OPT 11 SCHEMATIC
	3	30444	REF	58900	30444	854XC OPT 11 TEST PROC
C	1	CT16-S5100	1	2M734	ECS-T1CY105R	1 UF 16 V TANTALUM SMT
C	2	CK50-03100	1	31433	C0805C103KRACTR	.01 UF X7R CHIP
C	3	CK55-04100	1	2M734	ECUV1H104MEM	.1 UF CERAMIC CHIP Z5U
C	4	CK55-04100	1	2M734	ECUV1H104MEM	.1 UF CERAMIC CHIP Z5U
C	5	CK55-04100	1	2M734	ECUV1H104MEM	.1 UF CERAMIC CHIP Z5U
C	6	CK55-04100	1	2M734	ECUV1H104MEM	.1 UF CERAMIC CHIP Z5U
C	7	CK55-04100	1	2M734	ECUV1H104MEM	.1 UF CERAMIC CHIP Z5U
C	8	CK55-04100	1	2M734	ECUV1H104MEM	.1 UF CERAMIC CHIP Z5U
C	9	CK55-04100	1	2M734	ECUV1H104MEM	.1 UF CERAMIC CHIP Z5U
C	10	CK55-04100	1	2M734	ECUV1H104MEM	.1 UF CERAMIC CHIP Z5U
J	1	21168	1	55322	SSW-125-01-T-D	50 PIN STRIPLINE SOCKET
L	1	LFM0-00001	1	02113	0805CS-181XKBC	FERRITE BEAD FILTER SMT
L	2	LFM0-00001	1	02113	0805CS-181XKBC	FERRITE BEAD FILTER SMT
R	1	21445-011	1	65970	MCR10EZHFX1002	10.0K OHM 1% FILM SMT
R	2	21445-011	1	65970	MCR10EZHFX1002	10.0K OHM 1% FILM SMT
R	3	21445-011	1	65970	MCR10EZHFX1002	10.0K OHM 1% FILM SMT
R	4	21445-011	1	65970	MCR10EZHFX1002	10.0K OHM 1% FILM SMT
U	1	UGD0-03042	1	68994	XC3042A-7PQ100	PROGRAMMABLE GATE ARRAY
U	2	UTD0-02453	1	01245	74HCT245DW	74HCT245DW OCTAL BUS SMT
U	3	UTD0-02453	1	01245	74HCT245DW	74HCT245DW OCTAL BUS SMT
U	4	OX00-00012	1	54331	970H2B2A-12.00	12 MHZ OSCILLATOR
U	5	30627	1	63542	30627	PROG PROM 854XC OPT 11 U5
XU	5	JSP0-10008	1	09922	DIL08P-108T	8 PIN DIP SOCKET

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